SPATIAL AND TEMPORAL CLIMATE VARIATIONS INFLUENCING MEDIUM-RANGE TEMPERATURE PREDICTIONS OVER SOUTH-CENTRAL EUROPEAN RUSSIA

A Thesis

by

JEFFREY EDWARD JOHNSON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

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May 1990

ABSTRACT

Spatial and Temporal Climate Variations Influencing Medium-range Temperature Predictions over South-central European Russia. (May 1990)

Jeffrey Edward Johnson, B.S., University of Colorado

Chair of Advisory Committee: Prof. John F. Griffiths

To issue medium-range forecasts, forecasters should integrate climatology, synoptic meteorology, statistics, local topography, computer science, human experience and judgment. Often times, if forecasts extend beyond 72 hours, a systematic approach is abandoned for a more haphazard one. The aim of this research is to reduce a forecaster's guesswork and make the forecast methodology more objective.

A general climatology was developed for south-central European Russia. Monthly and diurnal trends are easily noted. One station, Astrakhan, was selected for a more detailed climatology. A monthly overview for 9 stations in the region is given for the weather elements as stated above. Pentad and 3-hourly averages are also included. The detailed climatology is helpful in orienting a new weather forecaster to the peculiarities of a novel region.

Regression equations were developed using lag functions of 1-5 days. Low and high temperatures for the forecast period were regressed back to day zero. Low and high temperatures are predicted for 1-5 days past the initial forecast day.

The regression equations developed from some 24 years of data have a higher percentage of correctly predicting temperatures at the times mentioned than do climatology, persistence, or combinations thereof.

Keywords: Theses; Regression analysis; Diurnal variations; Weather observation; USSR/Europe; Weather forecasting; Military operations; Time/[illegible] [illegible]. (M[illegible]

DEDICATION

To my teachers, especially mom and dad.

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CHAPTER I

INTRODUCTION

Medium-range military operations require knowledge of weather at least several days into the future. Knowing specific weather elements is essential for planning purposes and for successful operations (Jacobs 1947).

The United States National Weather Service, USAF Air Weather Service, and USN Fleet Numerical Central are among agencies that currently issue regional weather forecasts. It is the job of the local forecaster to interpret and modify generalized forecasts for his or her specific area of interest. To achieve tailored weather forecasts, forecasters should integrate the following disciplines or topics: climatology, synoptic meteorology, statistics, geography or local topography, computer science, human experience and human judgment. As in any science, to achieve objectivity, the aim is to minimize human subjectivity. To do so requires a systematic approach to the problem. Many people issuing extended forecasts do so haphazardly or with "gut feelings." The aim of this study is to reduce the forecaster's guesswork when issuing medium-range temperature forecasts.

Objective

The purpose of developing these medium-range weather forecasting models is to allow a forecaster to issue a "5-day temperature forecast" objectively with limited data. Required ingredients for the model are climatology for the station, and today's

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This thesis follows the style based on the journal *Monthly Weather Review*.

and the previous day's synoptic weather observations. The model will predict high and low temperatures 1 through 5 days out.

Basic Problems

Two problems will be tackled. First, a climatology for south-central European Russia will be developed. Second, a predictive model for high and low temperatures will be developed. The problems are obviously intertwined.

Given an initial state of the atmosphere, the fundamental problem of numerical weather prediction is to determine a future state by integrating the system of hydrodynamic and thermodynamic equations which describe physical processes occurring in the atmosphere. The complexity of processes these equations represent offer great difficulties in direct analytical solutions. The application of climatological records to the forecast procedure has been rather limited. Also, the field of climatology generally has been viewed as offering little help to the weather forecaster. Actually, climatology is of very great assistance inasmuch as it can be thought of as the "experience" which is perhaps the most powerful tool which the forecaster can bring to bear, especially in medium and long-range forecasting (Bundgaard 1951). What is required is to organize the climatological data in such a way that its usefulness can be substantially enhanced.

The problem at hand involves statistical, meteorological, and computational (computer) techniques. The statistical approach requires the use of basic statistics and elementary time series. Meteorological aspects were considered from the viewpoint of synoptic climatology, so-called because by its very nature the approach is

Figure 1. Study Area: South-central European Russia

climatological; yet because it deals with individual weather situations, it may also be called synoptic. The computer work used Statistical Analysis System (SAS), a software system designed especially for data analysis.

Data

The area of interest is 45° N to 55° N latitude and 25° E to 55° E longitude. This area lies in south-central European Russia, north of the Caspian and Black Seas (Fig. 1). Dates of interest are January 1959 to December 1986.

Magnetic tapes of 3-hourly surface synoptic data were obtained from the USAF Environmental Technical Applications Center at Asheville, North Carolina. The data

included: station identifier, year, month, day, observation time; wind direction, wind speed, dry bulb temperature, dewpoint depression, station pressure, visibility, sky condition, ceiling height, total precipitation for the past 6 hours, and current weather. Nine stations were selected in the above grid area based on the availability of 3-hourly synoptic observations and at least 20 years of record.

CHAPTER II

LITERATURE REVIEW

The geographical distribution and seasonal occurrence of planetary and synoptic scale systems are fairly well known, but on the mesoscale this is not the case. Moreover, interactions of the larger scales of motion are influenced by geographical controls. Thus, the planetary wave pattern is related to heat sources and sinks as well as to large-scale orography, and the formation and movement of frontal depressions is in part governed by these planetary waves. Mesoscale systems appear to be related both to geographical features and to larger scale systems (Hare 1957).

A regional macroclimate may be accounted for in general terms by reference to planetary wave patterns and particular regimes of synoptic and mesoscale disturbances on seasonal and shorter time scales (Feyerherm and Bark 1965). Synoptic climatology can provide a vital link between hourly and daily climatology data. Also, by its attention to long-term synoptic variability, synoptic climatology can play a major role in developing our understanding of world climate (Barry and Perry 1973).

If an individual map of the pressure field is considered, the static pattern may be classified into one of two main categories:

(1) the identification of individual circulation features such as high and low pressure cells, and ridges and troughs in specific locations, and

(2) a description of the complete pressure pattern, or its most significant features, by subjective or objective methods (Baur 1951).

The isobaric chart may also be regarded in a kinematic framework. Two important lines of this work are:

(1) the classification of cyclone and anticyclone paths, and

(2) the classification of circulation or airflow patterns.

Finally, meteorological and climatological elements may be treated directly. Three possible approaches are:

(1) the decomposition of selected elements into specific weather types,

(2) the identification of air masses on the basis of selected parameters, and

(3) the abstraction of combined weather factors by means of mathematical techniques (averages, means, deviations, *etc.*).

Because subjective analyses of pressure fields pose many problems, objective classification techniques should be used. The primary methods are correlation techniques, specification techniques, and empirical orthogonal functions (EOFs).

Extrapolation and kinematic techniques also are used in forecasting. These procedures depend on the assumption that salient circulation features are shifting in a quasi-regular manner. Experience suggests that this is most appropriate when upper air charts have well-delineated troughs and ridges and strong tendency fields. The method becomes unreliable when flow patterns are weak. Also, developing circulation modes cannot be predicted by extrapolation procedures (Wadsworth *et al.* 1948).

Forecasts are generally successful when dealing with time scales up to a few days. But the day-to-day movement of low and high pressure centers is often

roughly the same order of magnitude as their dimensions. This rapid motion of weather systems, coupled with erratic path, speed, and development, points to the difficulty of forecasting for more than a day or two by using standard forecast methods of interpolation and extrapolation (Neiburger *et al.* 1982). The most successful extended-range forecasting procedures must involve the current state of the atmosphere and the manner and rate of evolution. Forecast methods which do not include evolution of systems usually limit success.

The main purpose of utilizing theoretical distribution models is to describe the observed statistical or stochastic properties by the most suitable and reasonable functions for each climatic element (Namias 1953). Different characteristics caused by different locations and/or different time periods may be explained by discrepancies of estimated parameters under the same distribution model. Hence, many trial and error proposals of applying different types of distribution models to specific climatic elements will not always be appropriate in comparing or interpreting climatological data, even if the goodness of fit test shows the acceptance of the hypothesis in each model (Suzuki 1979).

In the estimation of the parameters for an applied distribution model, the maximum likelihood (ML) method should be emphasized above all others. A problem arises though, the ML estimators are usually biased. Also, the asymptotic sample variances of the ML estimators are not always sufficiently clear in statistical climatology.

Suzuki believes that three statistical tests are required in order to model climatic fluctuations or sequences, namely, the significance test of trend, the test of harmonic coefficients, and ergodicity (the test of whether or not any state could occur).

In forecasting the state of the atmosphere at grid points, there is a problem of obtaining vector-valued estimates of meteorological variables at a grid point based on multivariate information from several sources. The problem is to find the "best" linear combination of the criterion by minimizing the variances of the estimators.

Several examples of statistical prediction schemes in climatology are available. Most predictions are based on a number of predictor variables, for example wind speed, temperature, and sea level pressure. While prediction can be made more accurate by bringing in as many relevant predictor variables as possible, some of them may be highly correlated among themselves and the individual contribution of some may be marginal. The problem of selecting the best set of predictor variables arises in various situations. Stringer (1972) cited some examples from the literature regarding prediction and visibility. Martin *et al.* (1963) considered an example dealing with forecasting of the 24-hour movement and change of central pressures of North American winter anticyclones.

Several criteria for defining the best set of predictor variables and various techniques for selecting the best set have been discussed in a paper by Hocking (1976). Thompson (1978) also prepared a review article and evaluated several significant methods. Martin *et al.* (1963) suggested a forward type stepwise procedure, whereas Lund (1971) used a blended stagewise and stepwise procedure. These papers offer a general approach to variable selection. No one method will always work in every

situation. Also, none of these techniques for selecting the best set of predictor variables are designed to produce a best set with a guaranteed probability (Gupta and Panchapakesan 1979).

Statistical weather forecasting is based on the principle of making predictive inferences about future weather from statistics of past weather. A meteorological element is to be forecasted from observations of the same or other meteorological elements at previous times. Usually, the mathematical form of the relationship is not known, and such relationships must be determined empirically.

Statistical forecasting methods are mainly objective, being completely objective as far as the forecaster is concerned. Given values of the predictors, the best forecast of the predictand is uniquely determined by the model. However, some degree of subjectivity and judgment enters the formulation of the procedure used in the forecast. Statistical weather forecasts will be nearly objective as possible without knowledge of the exact physical relationships between predictors and predictand. Also, statistical methods will make the most objective use of past weather information. Often times, objectivity in the design of forecast procedure can be increased only by an increase in the complexity of the method.

Formulation of statistical forecast methods follow three steps:

(1) The relation of the predictand to any number of predictors must be investigated, and the predictors most advantageous for the method must be selected.

(2) Convenient rules, graphs, or equations must be developed. These should be in a convenient form for use in future forecasts.

(3) The reliability of the chosen relation must be tested on a new set of observations of the predictors as well as the predictand.

Predictors should be selected on the basis of physical reasoning, if at all possible. For example, the occurrence of rain is known to be influenced by the amount of moisture in the air and vertical velocity. The vertical motion is often not measured directly, but is known from theory to be correlated with the north-south wind component or with thermal advection aloft. Hence, some moisture parameter (*e.g.*, humidity or dewpoint temperature) and some wind parameter (*e.g.*, wind direction at 850 mb and 700 mb) would be useful for precipitation forecasting.

Physical reasoning by itself, however, is not sufficient for the choice of predictors. There are several weather elements that indicate moisture in the atmosphere: wet-bulb depression, relative humidity, or dewpoint depression. Statistics of the predictors and the predictand observed in the past often indicate which element to choose.

Another important question involves the number of predictors. In theory, the more predictors, the better the prediction. In practice, one is always limited to a definite number of observations. A certain portion of the original data must be set aside for modifying and testing the model. If there were n predictors and only n observations of each, n linear equations which would exactly fit each observation of the developmental sample. But it would probably not fit future samples as well. The reason for this is that the developmental sample was fitted too well; it has explained with predictors variations in the predictand caused by observational error, small-scale or short-term fluctuations, or by elements not included in the set of n predictors.

In general, the number of predictors must be smaller than the number of usable observations of each predictor. Just how much smaller depends on the complexity of prediction method. If a linear regression equation is used, many predictors can be brought in. The addition of cross-products, quadratic, or higher order terms means that additional coefficients must be determined from the same data set. Since, effectively, the number of coefficients well determined from a given number n of observing periods is constant, this means that the number of predictors has to be reduced correspondingly.

It is difficult to state the optimum number of predictors, given n sets of observations. The number depends on the characteristics of the variables as well as on the kind of relationship to be established. Testing on independent data is likely to indicate whether too many predictors were used.

In most statistical forecast techniques, predictors are selected at the same point for every forecast. These places may be observing stations, or they may be grid points at which variables are known through some type of analysis. These techniques are called fixed-point techniques.

Though trajectory techniques may be physically more satisfactory, the main drawback is that air trajectories must first be determined objectively. Because construction of the trajectories is tedious and not terribly accurate if procedures are objective, these methods have been used only rarely in statistical weather forecasting.

There are several methods of statistical forecasting. Groupings might be:

(1) linear regression techniques,

(2) successive graphical regression techniques,

(3) stratification methods.

(4) residual methods, and

(5) combined methods.

Multiple linear regression became popular in the early 1950's due to its objectivity coupled with the advent of the electronic computer. Accuracy in prediction of numeric weather elements (pressure or temperature, for example) compares favorably with predictions based on dynamic considerations alone or those based on subjective synoptic techniques (Murphy *et al.* 1988).

Statistical regression techniques have the advantage over dynamic methods that no physical restrictions have to be made before the techniques can be applied, but there is no guarantee derived coefficients will be stable. In theory, statistically derived coefficients of a regression equation should shed some light on the physics of the atmosphere processes which lead to movement and development of synoptic patterns. Both physical and statistical methods should lead to the same set of forecasting equations.

Graphical regression is the subjective equivalent of non-linear regression if the predictand is numerical and of discriminant analysis if qualitative. Stratification methods consist of selecting class intervals for a number of predictors, and testing which combination of groups is favorable to certain properties of the predictand. Residual methods consist of correlating errors of forecasts based on one variable with another; hence, the second variable is used to correct forecasts based on the first. The process can be continued so that a third variable is used to make corrections based on the first two.

Combining forecast schemes is reported to provide more accurate predictions than individual forecasts alone. Considerable hindcast skill could be gained when combing two predictive schemes in an optimal (*i.e.*, error-minimizing) fashion. This method was applied to long-range forecasting of monthly mean tropical Pacific sea surface temperatures (Fraedrich and Smith 1989).

CHAPTER III

PROCEDURE

Building a temperature forecast model requires several ingredients. First, topography must be considered. Is wind direction "locked in" a particular direction by nearby mountain ranges? Is the station at such an elevation that it affects its weather? Second, a climatology must be developed. The aim is for useful detail, but limited data and resources may negate the most useful climatology for an area. Is there a need for monthly, weekly, or hourly averages? What time period is going to be most useful to the forecaster? Whichever format one chooses, the climatic tables should be helpful to the forecaster, *i.e.*, referenced often. Climatic tables that sit on a shelf and are accessed twice a year are not particularly useful. Third, which modeling approach works best for the weather parameter to be forecasted? The model needs to be developed from available data. Once these aspects of the model are organized, it needs to be tested. This chapter will go through the process of constructing a climatology for the region and building a medium-range temperature forecasting model.

Figure 2. Map of the Soviet Union with the study area outlined.

Topography

South-central European Russia generally suffers from some degree of moisture deficit most of the year because of its distance from the Atlantic Ocean (Fig. 2). The southern two-thirds of the region is made up of the Black Sea steppes along the

plains. Elevations of any consequence are generally between 200–1000 m with the exception of the northeast portion of the study area where the southern extreme of the Ural mountains extend. Elevations here are in excess of 1000 m. Areas in the east and south tend to be more drought prone.

Qualitative Climatology

During the winter temperature and pressure gradients are at a maximum so that the atmospheric circulation is most intense, with large meridional components that bring widely varying air masses into close juxtaposition. Summer weather, on the other hand, is more the result of a combination of advective factors and on-site radiation exchanges, and therefore zonal characteristics of the earth's surface must be kept in mind when discussing summer climatic controls (Lydolph 1977).

General atmospheric circulation patterns over the Soviet Union are controlled by a relatively simple pattern of pressure centers which vary drastically from winter to summer. In winter, mean sea level pressure patterns reveal build-up of an intense high pressure system over the Asian land mass. The center generally overlies the Mongolian Peoples' Republic with a strong ridge extending westward into an area north of the Caspian and Black Seas. This winter protrusion is Voyeykov's (1948) so-called "great axis" which divides a generally northeasterly flow of air along the northern Black Sea coast from the southwesterly flow of air across much of European Russia. When it is well formed, this great axis protrudes all the way to the western coast of Europe and effectively blocks penetration of air and cyclonic systems from the Mediterranean region. It often acts as a wedge which divides routes of cyclonic

coast of Europe and effectively blocks penetration of air and cyclonic systems from the Mediterranean region. It often acts as a wedge which divides routes of cyclonic storms and sends them either northeastward into the Ob estuary or southeastward into the mountains of central Asia.

During the last week of February, negative tendencies in atmospheric pressure set in over the southern Urals and spread in all directions eventually covering much of European Russia. In April, a major change takes place in the sea level pressure pattern. The Asiatic high weakens and shifts its center westward to northeast Kazakhstan. It appears that what is now taking place is a shift from the dominance in the east of the Asiatic high to the dominance in the west of the Azores high protruding across Europe.

Throughout the summer a weak ridge extends eastward from the Azores high across central European Russia as far east as central Kazakhstan. In European Russia, as the western nose of the wintertime Asiatic high is replaced by the eastern nose of the summertime Azores high, surface winds generally shift from south or southwesterly to west or northwesterly (Lydolph 1977).

Contour patterns at 700 mb shift from a January situation, which shows a weak trough over western European Russia, to a July situation which shows a generally zonal flow across the country as a cool surface high over the Arctic turns to a weak low at the 700 mb level. Thermal effects on the circulation pattern accumulate upward until a weak trough at 500 mb appears over the Ob estuary. These subtle changes in pressure patterns at the surface and aloft produce significant changes in the direction of movement of cyclones and anticyclones during the winter and summer seasons.

Mid-August marks the culmination of summer, often when significant pressure changes begin to take place at the surface in European Russia. By mid-September a closed high has formed which is elongated in an east-west direction. This is the beginning of the shift from the dominance of the Azores high from the west. October brings a definite high pressure cell centered east of Lake Baykal. The Asiatic high remains rather consistent in this general location until mid-March.

The majority of fronts and cyclone tracks are positioned along the peripheries of the land mass. The polar front generally lies south of the USSR with a western segment in the Mediterranean-Asia Minor-Middle East area. This western segment spawns many cyclonic storms which affect the Soviet Union. Those forming in the eastern Mediterranean typically move northeastward across the Black Sea-Caucasian area. Thus they pull the polar front far northward into the country.

Fronts which affect most of the Soviet Union this time of year are segments of the Arctic front. These fronts sweep across the breadth of the country, particularly the European sector, as far south as the Black Sea and Caspian Sea.

Many of the cyclonic storms which affect the Soviet Union in winter originate either in the Icelandic low or in the Mediterranean and are shunted along northern and southern borders of European Russia by the western protrusion of the Asiatic high.

Quantitative Climatology

Appendices B-J, pages 54–135, show the general climatology for south-central European Russia. Weather elements are summarized by month and time (morning and afternoon). Notable trends in data are:

1. Greatest variability during winter for temperature, visibility, SLP, and ceiling height.

2. Largest variation in temperature for winter months, late night and early morning hours.

3. Greatest variation in temperature for afternoon hours during summer months.

One station, Astrakhan, was chosen for a detailed climatology (see Appendix B, pages 54–111) consisting of monthly, pentad, and 3-hourly averages. This type of detail can give a forecaster a better feel for diurnal and seasonal trends in the various weather elements until he acquires practical forecast experience. Noticable trends are annotated on individual tables in appendix B.

Model Construction

The review section presented several modeling approaches. The methods vary widely in terms of forecasting accuracy, constraints they impose on the user, and their complexity and intuitive appeal to the user. Given the wide choice of alternative forecasting methods available, it is particularly useful for the forecaster to have criteria that can be used in selecting and comparing alternative methodologies.

Effective forecasting methodology for a given situation has two prerequisites. First, a range of alternatives must be understood and recognized. Second, some systematic procedure for comparing strengths and weaknesses of alternative methods in different situations should be used. The following sections will provide such a framework.

Criteria for comparing and selecting a forecasting method can be organized in several ways. The organization used here establishes a set of priorities for the criteria so that those most important can be considered first. Under any system, the accuracy of a forecast is given top priority.

Unfortunately, forecasters generally terminate the evaluation process after this first criterion of accuracy has been examined. A number of other criteria are also very important as a part of this evaluation process. These criteria include: data pattern to be forecast, forecasting time horizon to be covered, cost of applying alternative methodologies, and ease of application (Makridakis and Wheelwright 1978).

Data pattern is important in selecting a forecasting method because different methods can cope with only certain kinds of data patterns. Some methods can cope with a very wide range of patterns, but these are usually difficult to build and difficult to apply; thus a trade-off is involved using them. Generally, the pattern element can be divided into two main subparts; patterns that repeat in time (trend and seasonal components) and patterns that are aperiodic and do not repeat over fixed time intervals.

The time horizon criterion for evaluating forecasting methods is closely related to the pattern criterion. Time horizon refers to the time length of forecast (*i.e.*, 2 days, 5 days, *etc.*). Closely related to time horizon to be forecast is the time required to actually prepare the forecast. If one has 6 hours to prepare a forecast the approach will be different than if the preparation time is only 30 minutes.

Cost elements sometime must be used as a trade-off against such things as accuracy, ease of application, and pattern. Data requirements, computer time and

human resources, training forecasters in use of new forecasting methodology, and use of the model on an ongoing basis needs to be considered under the cost element.

Ease of application might be thought of as a criterion that brings together other considerations not covered by the previous criteria. Complexity, timeliness that forecasts provide, the level of knowledge required for application, and the conceptual basis and ease with which it can be conveyed to the final user of the forecast are all important considerations. A common stumbling block in adoption of an appropriate forecasting technique is making users comfortable with the technique and its rationale so that they can effectively judge the results of the forecasting method and its usefulness (Panofsky and Brier 1976).

After comparing models in the review section and considering the above criteria for a suitable model, the linear regression approach was chosen. Ease of application to this particular data set was a major reason in choosing the regression method. Since the data set only contains surface synoptic data, other more elaborate schemes were abandoned.

Developing the Regression Equation

Multiple regression is defined as the amount of change in a dependent variable associated with a unit change in independent variables. The equation for multiple regression analysis is:

$$Y = a_0 - a_1 x_1 + a_2 x_2 + \dots - a_n x_n \tag{1}$$

where n is the number of independent variables, and a_n is the coefficient of regression. In general, a_n represents an expected change in y for a unit change in x_n, holding all

variable or variables in multiple regression analysis. A correlation between two or more variables describes the strength of the linear relationship between them. Large correlations infer a strong relationship while small correlations do not necessarily infer any relationship. One would have to determine whether the correlation was due to sampling errors. All atmospheric elements are interrelated to some extent even though the physical relationship may not be known at this time. Care must be exercised when forcing statistics on innocent data because relationships can be inferred when no actual cause and effect interrelation necessarily exists.

The MAXR method of stepwise regression analysis was implemented by SAS. The procedure begins by finding a one variable model which produces the highest R^2 (proportion of the variation among the observed values that is attributable to the fitted regression). Another variable is added which produces the greatest increase in R^2. Once a preliminary two-variable model is chosen, each of the variables in the model is compared to each variable not in the model. MAXR determines if removing one variable would increase R^2. After comparing all possible switches, the one that produces the largest R^2 is made. The process continues until MAXR finds that no switch increases R^2. The resulting two-variable model is the best two-variable model the technique can find. Another variable is added to the model and the process continues (Freund and Littell 1986).

Should cross-product or higher ordered terms be included in the regressions? A procedure that calculates all possible cross-product and quadratic terms for the independent variables in the model was implemented by SAS (RSREG). An F statistic

is given to indicate significance of each particular term along with an overall R^2 value for the model. The findings were:

(1) Quadratic terms and cross-product terms did not significantly increase the overall R^2 value for the model during winter.

(2) Quadratic terms generally not significant for summer.

(3) Cross-product terms significantly increase R^2 value during the summer over most every station. In some instances the amount of variation explained by cross-product terms more than doubled the overall R^2 values.

Testing the Model

Skill of a forecast should be defined in a strict statistical sense, that is, forecasts must show a higher proportion of successes than climatic probability of occurrence (Allen and Vernon 1951). The skill of forecast will be defined simply by the percent correct or total number of correct forecasts divided by the total number of forecasts issued (Brier and Allen 1951). A correct forecast will be defined within a specific tolerance. If the forecasted temperature is within 2°C of the actual temperature then the forecast will be judged correct. The score must be evaluated with respect to several forecast methods. Methods compared will be:

(1) climatology (defined as the monthly average temperature for morning and afternoon, respectively),

(2) persistence (defined as the present morning or afternoon temperature carried throughout the forecast period),

(3) climatology plus persistence divided by 2,

(4) regression, and

(5) regression combined with persistence and combined with climatology.

Coefficients of the regression equation will be developed from climatological data and use the current observation as input. Is 73% correct forecasts significantly different than a 68% correct forecast skill? This question must be answered when comparing different forecast schemes (*i.e.*, climatology, persistence, and regression) to determine which method is in fact "better" than the others. Procedure:

(1) Use the χ^2 test with 1 degree of freedom.

(2) The percent correct value must be transformed into a numeric value (*i.e.*, the number of correct forecasts).

(3) Take, for example, 113 correct forecasts and 70 correct forecasts. Are they significantly different? Compute the test statistic:

$$\chi^2 = \frac{(113 - 70)^2}{70} = 26 \tag{2}$$

(4) χ^2 must be larger than 3.84 at $\alpha = 0.05$ level of significance to be considered significantly different. Because 26 is greater than 3.84, 113 correct forecasts are significantly "better" than 70 correct forecasts.

1970 was randomly selected as the test year. This year was deleted from the original data set and used as a verification period.

First, temperature was forecasted for up to 5 days. Dewpoint temperature was selected as an additional weather element to test the methodology of forecasting using a linear regression approach. Only winter morning dewpoint temperatures will be forecast.

CHAPTER IV

RESULTS

Temperature

1. The final forecasting model consists of 4 sets of 5 equations (total of 20 equations) for summer morning and afternoon, and winter morning and afternoon (Table 1). Systematic error in particular lags (mostly lag 2, but not always) was caused by the interpretation of missing values by SAS (Fig. 3 and Fig. 4). Eliminating missing values completely, plus deleting extreme values of temperature, dewpoint temperature, and sea level pressure appears to have abated the problem. It appears coefficients for a particular season and time are specific to that domain, *id est*, while spatially averaged regression coefficients produce acceptable forecasts of temperature, using averages for the day (*i.e.*, morning and afternoon) or averages for the year (*i.e.*, summer and winter) do not produce satisfactory forecasts.

a) Persistence showed a higher percentage of correct forecasts than climatology during winter months.

b) Climatology showed a higher percentage of correct forecasts than persistence during summer months.

c) The average of climatology and persistence (climatology plus persistence divided by two) always showed a higher percentage of correct forecasts than persistence alone for both the summer and winter seasons.

Table 1. Regression coefficients from 5-day temperature forecast model averaged over 9 stations.

SUMMER AM	TEMP	DEWPT	QUAD	SLP
DAY + 1	0.184	0.153	-0.170	-0.027
DAY + 2	0.408	0.071	-0.044	-0.018
DAY + 3	0.244	0.079	-0.162	-0.022
DAY + 4	0.495	-0.017	-0.163	-0.010
DAY + 5	0.132	0.126	-0.125	-0.013

SUMMER PM	TEMP	DEWPT	QUAD	SLP
DAY + 1	0.531	0.156	-0.199	0.146
DAY + 2	0.889	-0.053	-0.157	0.208
DAY + 3	0.273	0.234	-0.213	0.234
DAY + 4	0.633	0.075	-0.105	0.189
DAY + 5	0.392	0.158	-0.211	0.248

WINTER AM	TEMP	DEWPT	QUAD	SLP
DAY + 1	0.592	0.212	0.064	0.032
DAY + 2	0.486	0.237	0.113	0.056
DAY + 3	0.252	0.406	0.199	0.048
DAY + 4	0.594	0.125	0.291	0.052
DAY + 5	0.436	0.146	0.229	0.073

WINTER PM	TEMP	DEWPT	QUAD	SLP
DAY + 1	0.463	0.284	0.088	0.042
DAY + 2	0.370	0.298	0.128	0.069
DAY + 3	0.253	0.364	0.201	0.064
DAY + 4	0.619	0.130	0.242	0.083
DAY + 5	0.296	0.258	0.237	0.100

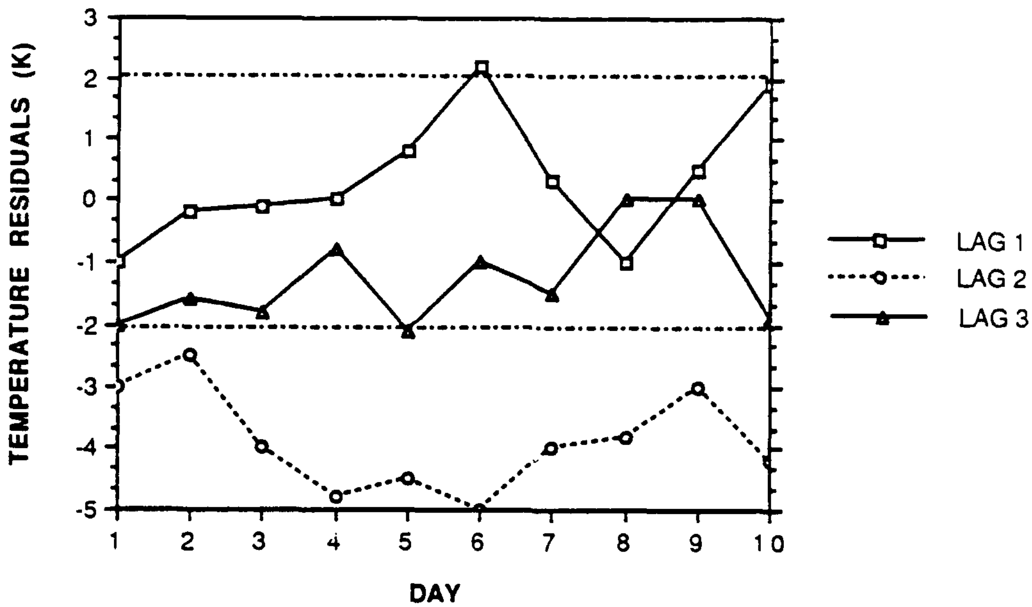

Figure 3. Temperature residuals for 5-day temperature forecasts with systematic error.

d) The average of climatology and persistence showed a higher percentage of correct forecasts than climatology alone during winter months (Table 2).

e) Climatology alone showed a higher percentage correct forecasts during the summer than the average of climatology and persistence (Table 3).

f) Climatology alone showed a higher percentage of correct forecasts in July mornings than any other forecast scheme.

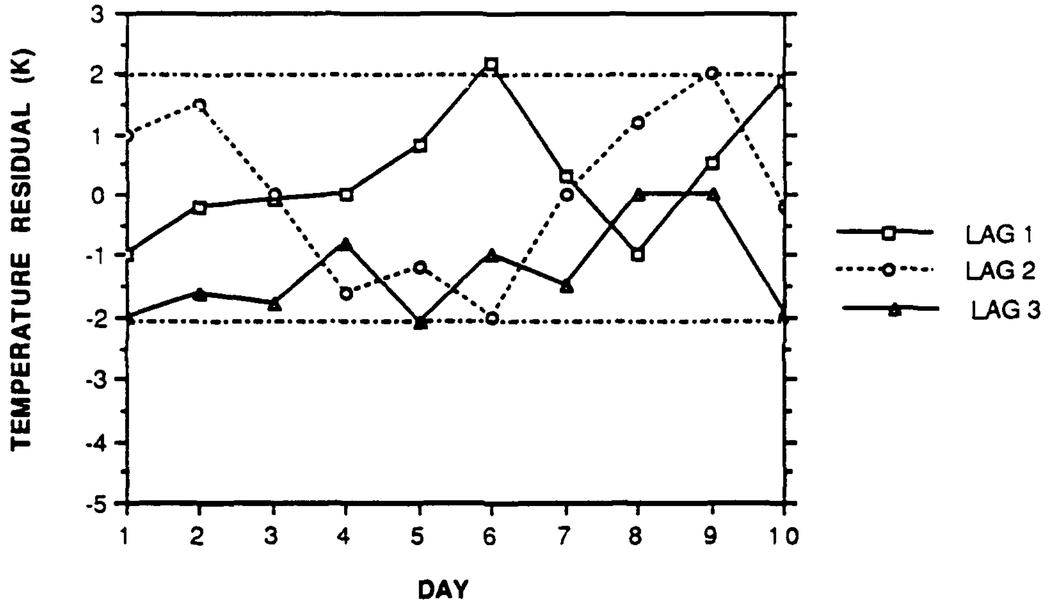

Figure 4. Temperature residuals for 5-day temperature forecasts with systematic error removed.

2. Because the 4 variable prediction model for high and low temperature showed higher skill (percent correct) in forecasting these temperatures than persistence or climatology, it was chosen to forecast temperatures 1-5 days into the future (Table 4).

a) Fig. 5 indicates the regression equation had a higher skill than the average of persistence and climatology in all but three cases (total of 108 cases).

Table 2. A percent correct (%) forecast comparison using persistence (P), climatology (C) and the average regression equation (R) in 5-day temperature forecasts, by station, lags 1–5 (test year 1970).

STATION 1: ASTRAKHAN, RS

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	36	30	38	38	35	34	18	22	25	23	22	20
C	38	42	13	35	56	14	56	73	76	52	35	57
(P+C)/2	55	51	12	71	60	59	45	45	40	28	32	29
R	71	82	61	77	77	65	86	65	89	58	80	52
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 2: ORENBURG, RA

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	22	30	19	25	23	23	18	20	24	18	16	20
C	12	9	26	31	15	0	36	50	54	20	54	27
(P+C)/2	46	29	24	48	22	31	42	35	37	22	32	26
R	48	68	50	50	54	39	71	81	73	41	81	70
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 3: KALMIKOVO, RA

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	21	23	28	31	20	26	21	20	23	18	22	18
C	27	15	0	23	19	13	68	65	65	44	38	31
(P+C)/2	45	56	18	52	29	27	44	39	41	22	32	25
R	62	78	60	60	37	63	63	38	57	53	71	62
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

Table 2. Continued

STATION 4: GURYEV, RA

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	24	25	32	25	30	34	19	20	22	18	22	24
C	27	31	13	31	35	64	48	62	60	48	50	27
(P+C)/2	42	63	16	60	36	36	46	37	38	26	32	28
R	67	82	57	72	48	60	80	57	77	52	78	61
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 5: RYAZAN, RS

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	40	38	32	44	50	29	27	24	28	22	18	29
C	19	23	9	31	19	30	52	46	54	44	31	38
(P+C)/2	44	50	29	59	48	45	57	35	42	26	35	37
R	92	92	77	82	84	75	87	44	79	51	75	78
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 6: PENZA, RS

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	40	30	25	51	33	28	22	20	24	23	20	32
C	35	19	4	38	27	13	24	46	50	20	54	19
(P+C)/2	48	40	28	54	53	31	42	35	48	24	30	25
R	41	63	40	71	64	63	69	62	75	38	68	53
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

Table 2. Continued

STATION 7: KUYBYSHEV, RA

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	33	23	18	37	22	27	26	18	22	23	22	26
C	12	19	13	19	42	35	32	65	38	24	35	42
(P+C)/2	22	56	56	25	53	50	46	36	49	16	32	28
R	28	62	63	48	53	62	71	62	76	56	63	51
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 8: VOLGOGRAD, RS

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	38	39	34	44	43	42	18	21	28	21	22	18
C	23	12	5	27	27	14	44	46	58	24	50	46
(P+C)/2	46	61	15	61	51	25	41	36	49	28	31	30
R	75	83	59	78	62	67	57	55	86	49	80	68
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

STATION 9: ROSTOV-ON-DON, RS

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	35	26	18	42	29	21	20	23	22	23	24	29
C	15	8	26	12	19	22	52	54	27	20	54	19
(P+C)/2	42	27	40	44	27	49	35	36	25	31	42	49
R	64	79	73	78	72	76	75	59	68	50	75	57
TOTAL FORECASTS	130	130	115	130	125	110	125	130	125	125	130	130

Table 3. A percent correct (%) forecast comparison using persistence (P), climatology (C), and the average regression equation (R) in 5-day temperature forecasts, averaged over all stations (test year 1970).

	WINTER						SUMMER					
	MORNING			AFTERNOON			MORNING			AFTERNOON		
FORECAST METHOD	DEC AM	JAN AM	FEB AM	DEC PM	JAN PM	FEB PM	JUN AM	JUL AM	AUG AM	JUN PM	JUL PM	AUG PM
P	32	29	27	37	32	29	21	21	24	21	21	24
C	23	20	12	27	29	23	46	56	54	33	45	34
(P+C)/2	43	48	26	53	42	39	44	37	41	25	33	31
R	61	77	60	68	61	63	73	53	76	58	75	61
TOTAL FORECASTS	1170	1170	1035	1170	1125	990	1125	1170	1125	1125	1170	1170

3. A 2-day wave in the temperature field was discovered. Though present most of the year, its strongest signal occurred in summer morning (Fig. 6 and Fig. 7) .

a) R^2 values for winter were significantly higher than R^2 values for summer.

b) Afternoon R^2 values were higher than morning R^2 values for both summer and winter.

c) The slope of the line for R^2 vs lag was typically -0.6 for summer and -1.0 for winter forecasts. A steeper slope would indicate a more rapid decay of forecast skill as time progressed.

d) Forecasts combined for lags 1–5 were broken down into respective lags. Percent correct forecasts were: 71, 98, 61, 65, and 10%, respectively.

Table 4. A percent correct (%) forecast comparison using a) station specific regression coefficients and b) averaged regression coefficients over 9 stations in the 5-day temperature forecast model, lags 1–5 (test year 1970).

a)

	STATION NUMBER								
SEASON AND TIME	1	2	3	4	5	6	7	8	9
	PERCENT CORRECT (%)								
WAM	74	65	57	59	87	69	71	83	72
WPM	78	54	63	59	80	66	64	88	75
SAM	80	77	67	71	70	59	78	78	67
SPM	63	74	62	64	68	63	67	68	66

b)

	STATION NUMBER								
SEASON AND TIME	1	2	3	4	5	6	7	8	9
	PERCENT CORRECT (%)								
WAM	72	56	48	51	73	67	69	83	72
WPM	73	48	60	54	69	53	60	81	75
SAM	78	75	67	70	66	52	71	70	63
SPM	63	64	49	57	66	62	64	68	61

WAM = WINTER MORNING: Dec, Jan, Feb; (04+07)LST/2
WPM = WINTER AFTERNOON: (13+16)LST/2
SAM = SUMMER MORNING: Jun, Jul, Aug
SPM = SUMMER AFTERNOON

% CORRECT = Forecast temperature within ± 2K of actual temperature.

Total number of forecasts for each time period: WAM = 375, WPM =365, SAM = 380, SPM = 385. Based on the sum of lags 1-5.

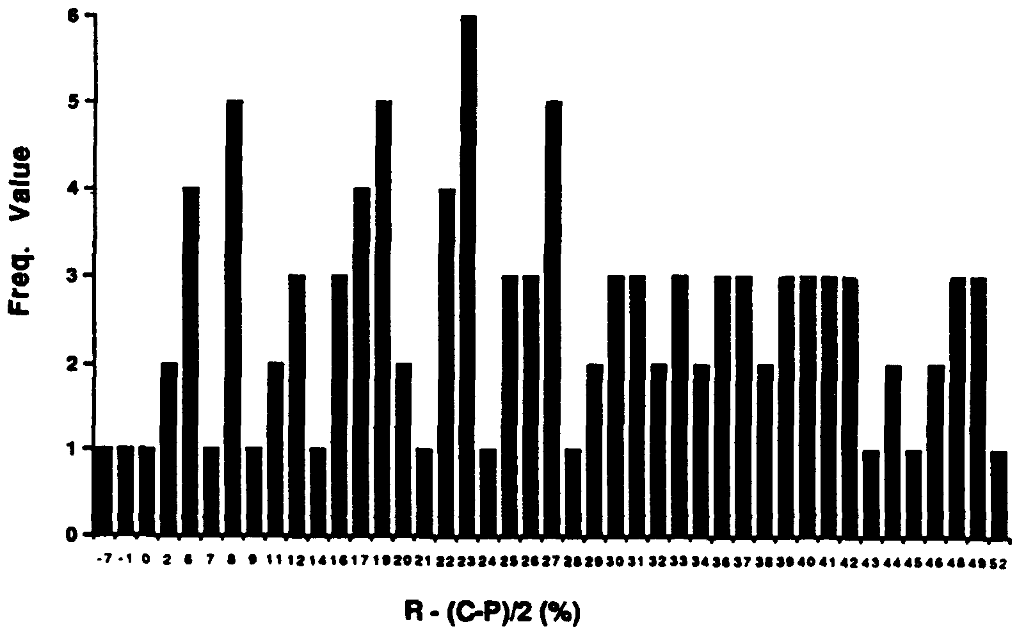

Figure 5. Frequency of the difference in average of persistence (P) and climatology (C) forecast from the regression forecast(R) in percent correct (%) forecasts (108 cases).

Dewpoint Temperature

1. A 3 variable model was selected to forecast dewpoint temperature (Table 5). The final forecast equation consisted of temperature, dewpoint temperature, and amount of sky cover. The ceiling element (low, middle, and high) was statistically significant only half the time. Coupled with the fact that R^2 only increased a percent or two, this weather element was not included in the final model.

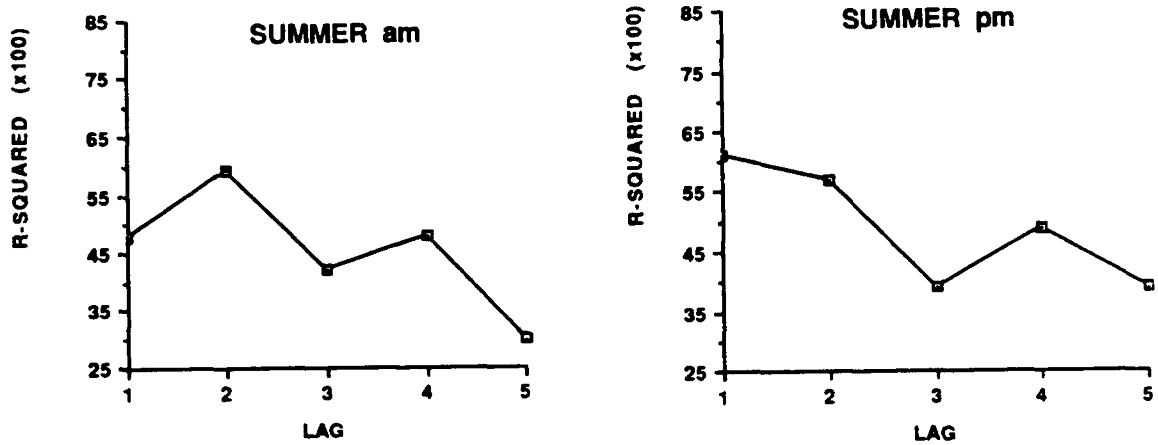

Figure 6. Summertime R^2 values vs lag

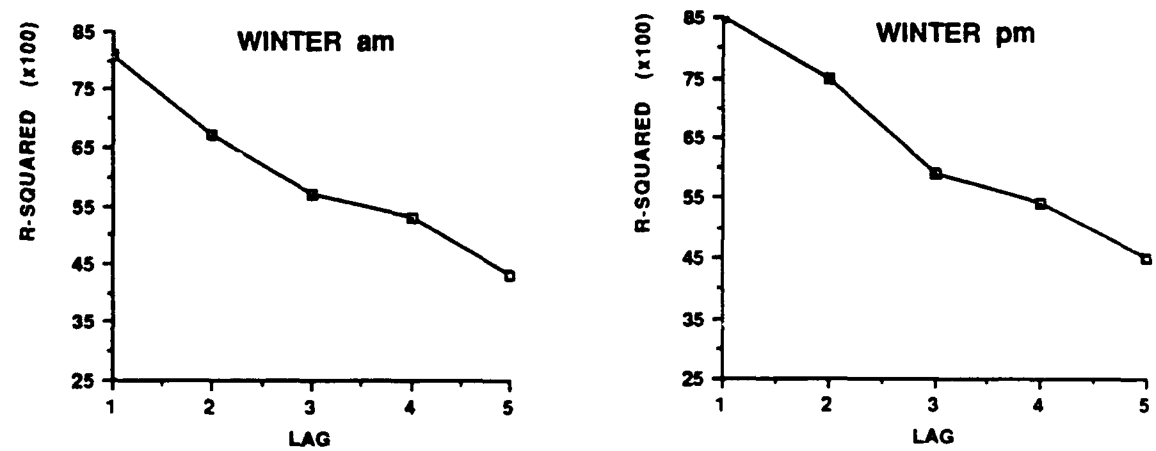

Figure 7. Wintertime R^2 values vs lag

Table 5. Regression coefficients from 5-day dewpoint temperature forecast model averaged over 9 stations.

WINTER AM	TEMP	DEWPT	SKY COVER
DAY+1	0.382	0.601	0.013
DAY+2	0.375	0.540	0.037
DAY+3	0.368	0.419	-0.008
DAY+4	0.372	0.398	-0.010
DAY+5	0.338	0.402	-0.011

a) Forecast dewpoint temperatures appear 2°C too cold through all lags and stations. This would appear to indicate that the test year was drier and/or cooler than the average for the period of record.

b) As in the temperature forecast model, average values for dewpoint temperature regression coefficients produced satisfactory forecasts (Table 6).

c) Table 7 shows the regression forecast once again holds the best forecast skill.

d) Table 8 (values averaged over all stations) shows persistence performs better than climatology for winter morning dewpoint temperature forecasts while combining persistence and climatology shows a marked improvement in forecast skill.

Table 6. A percent correct (%) forecast comparison using station specific regression coefficients and averaged regression coefficients over 9 stations in the 5-day dewpoint temperature forecast model, lags 1–5, winter morning (test year 1970).

	STATION NUMBER								
TYPE	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	PERCENT CORRECT (%)								
SPECIFIC	94	89	89	94	93	93	85	92	98
AVERAGE	87	82	87	80	79	88	83	85	89

WAM = WINTER MORNING: Dec, Jan, Feb; (04+07)LST/2
% CORRECT = Forecast temperature within ± 2K of actual temperature.

Total number of forecasts for each time period: WAM = 375. Based on the sum of lags 1-5.

Table 7. A percent correct (%) forecast comparison using persistence (P), climatology (C), and the regression equation (R) in 5-day dewpoint temperature forecasts at 9 specific stations, lags 1–5 (test year 1970).

STATION: 1

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	57	39	41
C	54	58	9
(P+C)/2	88	68	35
R	85	90	82
TOTAL FORECASTS	130	130	115

STATION: 2

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	42	27	29
C	31	8	39
(P+C)/2	74	58	35
R	88	81	77
TOTAL FORECASTS	130	130	115

STATION: 3

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	36	36	27
C	38	10	26
(P+C)/2	71	70	32
R	89	88	82
TOTAL FORECASTS	130	130	115

STATION: 4

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	46	30	40
C	38	12	4
(P+C)/2	62	82	26
R	77	83	80
TOTAL FORECASTS	130	130	115

STATION: 5

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	46	33	45
C	46	23	17
(P+C)/2	80	57	27
R	79	84	76
TOTAL FORECASTS	130	130	115

STATION: 6

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	37	28	24
C	42	27	9
(P+C)/2	63	45	31
R	88	91	86
TOTAL FORECASTS	130	130	115

STATION: 7

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	35	31	22
C	16	27	35
(P+C)/2	29	69	51
R	78	87	83
TOTAL FORECASTS	130	130	115

STATION: 8

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	45	32	35
C	35	31	9
(P+C)/2	87	59	27
R	87	90	78
TOTAL FORECASTS	130	130	115

STATION: 9

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	34	18	18
C	12	15	30
(P+C)/2	55	45	62
R	87	90	89
TOTAL FORECASTS	130	130	115

Table 8. A percent correct (%) forecast comparison using persistence (P), climatology (C), and the regression equation (R) in 5-day dewpoint temperature forecasts averaged over 9 stations, lags 1–5 (test year 1970).

FORECAST METHOD	DEC AM	JAN AM	FEB AM
P	42	30	31
C	35	23	20
(P+C)/2	68	61	36
R	84	87	81
TOTAL FORECASTS	1170	1170	1035

CHAPTER V

SUMMARY AND CONCLUSIONS

1. A detailed climatology can help orient a forecaster to a new location. It can serve as the forecaster's "experience" until they are accustomed to the weather peculiarities of the area.

2. The 4 variable regression equation; which uses temperature, dewpoint temperature, SLP, and wind direction to forecast high and low temperatures 1–5 days into the future, showed a higher skill than persistence, climatology, or the average of the two. A better comparison would have been to check the developed model against what is currently being used to forecast temperatures on this time scale. Unfortunately, the author could not find such bulletins.

a) χ^2 tests indicated the regression coefficients from specific stations must be used to forecast temperature. When average values for the coefficients were used, satisfactory results (within the specified tolerance) were obtained.

b) R^2 values were typically 0.45–0.65.

c) Using the arbitrary 2°C tolerance for correct forecasts, 60–85% were judged correct for the test year.

3. An increase in forecast skill (percent correct) can be obtained during summer months by including cross-product terms especially:

a) wind direction by ceiling height,

b) wind direction by SLP,

c) temperature by SLP.

d) temperature by amount of sky cover, and

e) dewpoint temperature by SLP.

An increase in skill may be attributed to the interactions of the above weather elements.

4. The 2-day wave in temperature field was not caused by frontal passage (FROPA). FROPA is not a regular 2-day event, rather a 4–5 day irregular event. (*i.e.*, the average frequency of FROPA is on the order of 4–5 days, but does not necessarily occur every 4th or 5th day). Increases in R^2 values from previous lags were, in fact, significantly different from each other. One possibility is an upper tropospheric wave manifesting itself in the temperature field. Such a wave could be quite regular and influence the temperature field such that the second and fourth days' forecast shows more skill than the first and fifth days' forecast, respectively.

a) Winter R^2 values are higher than summer R^2 values because there is a smaller range (average afternoon temperature minus average morning temperature) of temperature in winter.

b) Afternoon R^2 values are higher than morning R^2 values throughout the year because there is less variability in afternoon temperatures than morning temperatures.

c) Percent correct forecasts, by lag, followed the general pattern of R^2 values, that is, an increase in forecast skill was noted on days 2 and 4 compared to days 1 and 3, respectively. Because the forecast skill on day 5 decreased dramatically

(from 65% to 10% going from day 4 to day 5, respectively) using the regression equation, persistence or the average of climatology and persistence (percent correct forecasts were 27% and 26%, respectively) should be used to forecast temperatures on day 5. A definite conclusion cannot be drawn from the results though due to the facts that the sample size was small (only 25 days were forecast) and there was subjectivity in the definition of a "correct" forecast (*i.e.*, within 2K of the actual temperature).

5. High and low dewpoint temperatures forecast 1–5 days into the future used temperature, dewpoint temperature, and amount of sky cover as the independent variables.

6. Combining climatology and persistence significantly increased forecast skill compared to climatology or persistence alone for dewpoint temperature forecasts.

7. Comparing percent correct forecasts for persistence, climatology, and regression, dewpoint temperature showed a higher skill than the temperature forecast. One reason is probably due to less variability in dewpoint temperature than in temperature.

CHAPTER VI

RECOMMENDATIONS

1. Choose a data set that is complete, reliable, and easily accessible. Needless time will be wasted if this advice is not heeded. Often times there may be no choice in the matter.

2. Fill in the missing data via spatial and temporal interpolation, utilize other published data sources, and increase the period of record. Introduce additional stations to expand the study area.

3. Utilize 700 mb and 500 mb data from computer tapes for the same period of record. Also, introduce synoptic features into the model. Example: if a cold front is north of the station, drop the forecasted temperature by t degrees.

4. Expand the regression model to forecast other weather variables such as wind speed and direction, visibility, pressure, and sky condition. Also, expand the forecast period to each month of the year.

5. Concentrate on alternate modeling approaches such as non-linear regression, time series analysis, empirical orthogonal functions, *etc.* Also introduce trend variables in the model (*e.g.*, the difference in SLP from yesterday to today may indicate a low pressure system approaching the station). This information will be valuable and should be included in the forecast scheme.

6. Most of the number crunching should be done at a centralized facility where computer resources are handy. Specific stations should be tasked to define local

topography and descriptive climatology. The amount of data (at least 20 years?) to be utilized in developing useful regression forecast equations negates a local weather station from doing such because:

a) data files probably do not exist at this level and

b) a large enough computer to handle the data manipulation and statistical analysis probably is not readily available.

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APPENDIX A

COMPUTER PROGRAMS AND CALCULATIONS

This appendix contains the computer programs used to manipulate the data and run the regression equations.

COMPUTER PROGRAMS:

A-1. Climatology

A-2. Linear regression

A-3. Temperature forecasts with percent correct calculations

A-4. Comparison of full (specific coefficients) to the reduced model (average coefficients) using the TEST procedure

A-5. Comparison of climatology, persistence in percent correct forecasts

A-1

```
********************************************************************
******  THIS PROGRAM IS USED TO DEVELOP A CLIMATOLOGY FOR A STATION *****
********************************************************************
DATA PENTAD3;
INFILE IN1 MISSOVER;
INPUT ID YR MO DA HR DD SP SLP TEMP DEWPT PRECIP SKY VIS WX X CIG;
;
IF 1959<=YR<=1986 AND MO=12 THEN YR=YR+1;
;
*****************        DEFINE SEASONS AND TIMES      ********************
;
IF MO=1 OR MO=2 OR MO=12 THEN SEASON='WINTER';
ELSE IF MO=6 OR MO=7 OR MO=8 THEN SEASON='SUMMER';
ELSE DELETE;
;
IF HR=0 OR HR=3 THEN TIME='AM';
ELSE IF HR=9 OR HR=12 THEN TIME='PM';
ELSE DELETE;
;
******  DEFINE PENTADS.  IMPORTANT!  NOTICE HOW PENTAD 6 IS DEFINED. ****
******  THIS WILL RESULT IN AN UNEQUAL NUMBER OF OBSERVATIONS IN THIS ***
******  GROUP DEPENDING ON THE NUMBER OF DAYS IN THE MONTH!  ***********
;
IF 1<=DA<=5 THEN P=1;
  ELSE IF  6<=DA<=10 THEN P=2;
  ELSE IF 11<=DA<=15 THEN P=3;
  ELSE IF 16<=DA<=20 THEN P=4;
  ELSE IF 21<=DA<=25 THEN P=5;
  ELSE IF 26<=DA<=31 THEN P=6;
  ELSE DELETE;
;
**********  CALCULATE MEANS OF VARIOUS WEATHER ELEMENTS BY MO, SEASON, **
**********  AND TIME.  PRINT THE MEAN, NUMBER OF OBSERVATIONS IN CAL-  **
**********  CULATIONS, MAX AND MIN VALUE OF WX ELEMENT, VARIANCE,  ******
**********  STANDARD DEVIATION, AND COEFFICIENT OF VARIATION.   *********
;
PROC SORT;
  BY SEASON P TIME;
PROC MEANS NOPRINT;
  BY SEASON P TIME;
  VAR TEMP DEWPT VIS SKY SLP CIG PRECIP;
  OUTPUT OUT=NEW MEAN=TEMP DEWPT VIS SKY SLP CIG PRECIP
         N=NUMT NUMD NUMV NUMS NUMP NUMC NUMR
         NMISS=TMIS DMIS VMIS SMIS PMIS CMIS RMIS
         MIN=TMIN DMIN VMIN SMIN PMIN CMIN RMIN
         MAX=TMAX DMAX VMAX SMAX PMAX CMAX RMAX
         VAR=TVAR DVAR VVAR SVAR PVAR CVAR RVAR
         STD=TSTD DSTD VSTD SSTD PSTD CSTD RSTD
          CV= TCV  DCV  VCV  SCV  PCV CCV RCV;
;
******************        DELETE USELESS DECIMAL PLACES    ****************
;
DATA TRUNC; SET NEW;
  TEMP=ROUND(TEMP,.1);
  DEWPT=ROUND(DEWPT,.1);
  SLP=ROUND(SLP,.1);
  VIS=ROUND(VIS,.1);
  CIG=ROUND(CIG,.1);
  VMIN=ROUND(VMIN,.1);
  VMAX=ROUND(VMAX,.1);
  TVAR=ROUND(TVAR,.1);
  DVAR=ROUND(DVAR,.1);
  VVAR=ROUND(VVAR,.1);
  SVAR=ROUND(SVAR,.1);
  PVAR=ROUND(PVAR,.1);
;
PROC PRINT DATA=TRUNC; BY SEASON;
  VAR P TIME NUMT TMIS TMIN TEMP TMAX TVAR TSTD TCV
          NUMD DMIS DMIN DEWPT DMAX DVAR DSTD DCV
          NUMV VMIS VMIN VIS VMAX VVAR VSTD VCV
          NUMP PMIS PMIN SLP PMAX PVAR PSTD PCV
          NUMC CMIS CMIN CIG CMAX CVAR CSTD CCV;
```

A-2

```
************************************************************************
*******  THIS PROGRAM DIVIDES WEATHER ELEMENTS INTO CATEGORIES,  ********
*******  WEIGHTS THEM AND THEN USES LAG FUNCTIONS TO DEVELOP  ***********
*******  LINEAR REGRESSION EQUATIONS TO FORECAST A HIGH AND LOW  ********
*******  TEMPERATURE 1-5 DAYS IN THE FUTURE.  ***************************
************************************************************************
DATA PENTADO;
INFILE IN1 MISSOVER;
INPUT ID YR MO DA HR DD SP SLP TEMP DEWPT PRECIP SKY VIS WX X CIG;
IF 1959<=YR<=1986 AND MO=12 THEN YR=YR+1;
IF YR NE 1970;
IF TEMP=. THEN DELETE;
IF DEWPT=. THEN DELETE;
IF DD=. THEN DELETE;
IF SLP=. THEN DELETE;
;
IF MO=1 OR MO=2 OR MO=12 THEN SEASON='WINTER';
ELSE IF MO=6 OR MO=7 OR MO=8 THEN SEASON='SUMMER';
ELSE DELETE;
;
IF HR=0 OR HR=3 THEN TIME='AM';
ELSE IF HR=9 OR HR=12 THEN TIME='PM';
ELSE DELETE;
;
PROC SORT;
  BY SEASON DA TIME;
PROC MEANS NOPRINT;
  BY  SEASON DA TIME;
  VAR DD SP TEMP DEWPT PRECIP SKY VIS WX CIG;
  OUTPUT OUT=NEW MEAN=DD SP TEMP DEWPT PRECIP SKY VIS WX CIG;
DATA EST;
  SET NEW;
  BY SEASON DA TIME;
;
**********  DIVIDE THE WIND DIRECTION (DD) INTO THE 8 POINTS OF *********
**********  THE COMPASS THEN WEIGHT THE DIRECTIONS (HIGHER IF  **********
**********  DD IS FROM A SOUTHERLY DIRECTION, LOWER IF DD IS FROM  ******
**********  A NORTHERLY DIRECTION.  *************************************
;
IF      0<=DD<=22.5 AND SP>=2 THEN QUAD=1;
IF 342.5<=DD<=360  AND SP>=2 THEN QUAD=1;
  ELSE IF 22.5<DD<=67.5   AND SP>=2 THEN QUAD=2;
  ELSE IF 67.5<DD<=112.5  AND SP>=2 THEN QUAD=4;
  ELSE IF 112.5<DD<=157.5 AND SP>=2 THEN QUAD=6;
  ELSE IF 157.5<DD<=202.5 AND SP>=2 THEN QUAD=8;
  ELSE IF 202.5<DD<=247.5 AND SP>=2 THEN QUAD=7;
  ELSE IF 247.5<DD<=292.5 AND SP>=2 THEN QUAD=5;
  ELSE IF 292.5<DD<=342.5 AND SP>=2 THEN QUAD=3;
  ELSE IF SP<2 THEN QUAD=0;
;
**********  DIVIDE THE CEILING HEIGHT (CIG) INTO LOW, MIDDLE, AND  ******
**********  WEIGHT ACCORDINGLY.  ***************************************
;
IF          0<=CIG<=56 THEN C=10;
  ELSE IF 57<=CIG<=69 THEN C=25;
  ELSE IF 70<=CIG<=89 THEN C=50;
  ELSE IF 90<=CIG<=97 THEN C=10;
  ELSE DELETE;
;
*********************       WEIGHT THE SKY COVER (SKY)    ****************
;
IF SKY=0 THEN CLD=10;
  ELSE IF SKY=1 THEN CLD=10;
  ELSE IF SKY=2 THEN CLD=15;
  ELSE IF SKY=3 THEN CLD=20;
  ELSE IF SKY=4 THEN CLD=35;
  ELSE IF SKY=5 THEN CLD=50;
  ELSE IF SKY=6 THEN CLD=70;
  ELSE IF SKY=7 THEN CLD=80;
  ELSE IF SKY=8 THEN CLD=90;
  ELSE IF SKY=9 THEN CLD=100;
;
**********   DIVIDE THE WEATHER INTO GENERAL CATEGORIES (RAIN,   ********
**********   SHOWERS, SNOW...) AND WEIGHT.   ****************************
;
IF          4<=WX<=9  THEN W=10;
  ELSE IF 30<=WX<=39 THEN W=10;
  ELSE IF 40<=WX<=49 THEN W=20;
  ELSE IF 50<=WX<=59 THEN W=45;
```

```
        ELSE IF 60<=WX<=69 THEN W=60;
        ELSE IF 70<=WX<=79 THEN W=80;
        ELSE IF 80<=WX<=94 THEN W=65;
        ELSE IF 95<=WX<=99 THEN W=90;
      ;
      **********  CREATE A DATA SET WHICH WILL BE USED TO STORE THE LAG  ******
      **********  VARIABLES.  NEXT CREATE DATA SUBSETS FOR EACH LAG TO  *******
      **********  INCLUDE EACH WEATHER ELEMENT.  ****************************
      ;
      DATA ONE;
      DO YR=1959 TO 1987;
        DO MO=1,2,6,7,8,12;
          DO DA=1 TO 31;
            DO HR=0,3,9,12;
            OUTPUT;
            END;
          END;
        END;
      END;
      ;
      PROC SORT DATA=ONE; BY YR MO DA HR;
      PROC SORT DATA=PENTAD11; BY YR MO DA HR;
      DATA TWO;
        UPDATE ONE PENTAD11;
        BY YR MO DA HR;
      ;
          DATA L1;
            SET TWO;
              BY YR MO DA HR;
              T1=LAG(TEMP);
              P1=LAG(SLP);
              D1=LAG(QUAD);
              S1=LAG(SP);
              DP1=LAG(DEWPT);
              W1=LAG(W);
              C1=LAG(C);
              X1=LAG(CLD);
        IF DA=1 THEN DELETE;
      ;
        PROC SORT DATA=L1;
           BY  SEASON TIME;
      ;
          DATA L2;
            SET TWO;
              BY YR MO DA HR;
              T2=LAG2(TEMP);
              P2=LAG2(SLP);
              D2=LAG2(QUAD);
              S2=LAG2(SP);
              DP2=LAG2(DEWPT);
              W2=LAG2(W);
              C2=LAG2(C);
              X2=LAG2(CLD);
        IF 1<=DA<=2 THEN DELETE;
      ;
        PROC SORT DATA=L2;
           BY SEASON TIME;
      ;
          DATA L3;
            SET TWO;
              BY YR MO DA HR;
              T3=LAG3(TEMP);
              P3=LAG3(SLP);
              D3=LAG3(QUAD);
              S3=LAG3(SP);
              DP3=LAG3(DEWPT);
              W3=LAG3(W);
              C3=LAG3(C);
              X3=LAG3(CLD);
        IF 1<=DA<=3 THEN DELETE;
      ;
        PROC SORT DATA=L3;
           BY SEASON TIME;
      ;
          DATA L4;
            SET TWO;
              BY YR MO DA HR;
              T4=LAG4(TEMP);
              P4=LAG4(SLP);
              D4=LAG4(QUAD);
```

```
            S4=LAG4(SP);
            DP4=LAG4(DEWPT);
            W4=LAG4(W);
            C4=LAG4(C);
            X4=LAG4(CLD);
          IF 1<=DA<=4 THEN DELETE;
   ;
     PROC SORT DATA=L4;
        BY SEASON TIME;
   ;
       DATA L5;
         SET TWO;
           BY YR MO DA HR;
           T5=LAG5(TEMP);
           P5=LAG5(SLP);
           D5=LAG5(QUAD);
           S5=LAG5(SP);
           DP5=LAG5(DEWPT);
           W5=LAG5(W);
           C5=LAG5(C);
           X5=LAG5(CLD);
         IF 1<=DA<=5 THEN DELETE;
   ;
     PROC SORT DATA=L5;
        BY SEASON TIME;
   ;
   **********  IMPLEMENT A LINEAR REGRESSION PROCEDURE (LEAST SQUARES)  ****
   **********  THE FUTURE TEMPERATURE (TEMP) IS CORRELATED TO THE TEMP  ****
   **********  (T), DEWPOINT TEMP (DP), SLP(P), AND WIND DIRECTION (DD), **
   **********  N DAYS PREVIOUS, WHERE N = LAG.  ************************
   ;
   PROC SORT DATA=L1;
     BY SEASON TIME;
   PROC REG  DATA=L1 ;
     MODEL TEMP=T1 DP1 P1 D1;
   PROC REG  DATA=L2 ;
     MODEL TEMP=T2 DP2 P2 D2;
   PROC REG  DATA=L3 ;
     MODEL TEMP=T3 DP3 P3 D3;
   PROC REG  DATA=L4 ;
     MODEL TEMP=T4 DP4 P4 D4;
   PROC REG  DATA=L5 ;
     MODEL TEMP=T5 DP5 P5 D5;
```

A-3

```
**************************************************************************
**********  THIS PROGRAM TAKES THE REGRESSION COEFFICIENTS FOR A ********
**********  PARTICULAR WEATHER ELEMENT AND PREDICTS THE TEMPERATURE ****
**********  1-5 DAYS IN THE FUTURE.  THE PERCENT CORRECT (%) FORE-  *****
**********  CASTS ARE CALCULATED TOO.  **********************************
**************************************************************************
;
DATA PENTADZ;
INFILE IN1 MISSOVER;
INPUT ID YR MO DA HR DD SP SLP TEMP DEWPT PRECIP SKY VIS WX X CIG;
IF 1959<=YR<=1986 AND MO=12 THEN YR=YR+1;
;
IF YR=1970;
;
**********  BECAUSE THE FORECAST PERIOD IS 5 DAYS INTO THE FUTURE  ******
**********  AND ONLY "COMPLETE" FORECASTS (THE ENTIRE 5 DAY PERIOD)  ****
**********  ARE GOING TO BE ANALYZED, THE INITIAL FORECAST DAY WILL  ****
**********  END 5 DAYS PRIOR TO THE END OF THE MONTH.  ******************
;
IF MO=1 OR MO=7 OR MO=8 OR MO=12 THEN DO;
  IF DA<27;
END;
IF MO=2 THEN DO;
  IF DA<24;
END;
IF MO=6 THEN DO;
IF DA<26;
END;
;
IF MO=1 OR MO=2 OR MO=12 THEN SEASON='WINTER';
ELSE IF MO=6 OR MO=7 OR MO=8 THEN SEASON='SUMMER';
ELSE DELETE;
;
IF HR=0 OR HR=3 THEN TIME='AM';
ELSE IF HR=9 OR HR=12 THEN TIME='PM';
ELSE DELETE;
;
IF      0<=DD<=22.5 AND SP>=2 THEN QUAD=1;
IF 342.5<=DD<=360  AND SP>=2 THEN QUAD=1;
  ELSE IF 22.5<DD<=67.5   AND SP>=2 THEN QUAD=2;
  ELSE IF 67.5<DD<=112.5  AND SP>=2 THEN QUAD=4;
  ELSE IF 112.5<DD<=157.5 AND SP>=2 THEN QUAD=6;
  ELSE IF 157.5<DD<=202.5 AND SP>=2 THEN QUAD=8;
  ELSE IF 202.5<DD<=247.5 AND SP>=2 THEN QUAD=7;
  ELSE IF 247.5<DD<=292.5 AND SP>=2 THEN QUAD=5;
  ELSE IF 292.5<DD<=342.5 AND SP>=2 THEN QUAD=3;
  ELSE IF SP<2 THEN QUAD=0;
;
PROC SORT;
  BY  MO DA TIME;
PROC MEANS NOPRINT;
  BY  MO DA TIME;
  VAR TEMP DEWPT QUAD SLP;
  OUTPUT OUT=NEW MEAN=TEMP DEWPT QUAD SLP;
;
DATA EST;
  SET NEW;
  BY MO DA TIME;
;
IF MO=1 OR MO=2 OR MO=12 THEN SEASON='WINTER';
ELSE IF MO=6 OR MO=7 OR MO=8 THEN SEASON='SUMMER';
ELSE DELETE;
;
**********  THE COEFFICIENTS FOR THE PARTICULAR WEATHER ELEMENTS  *******
**********  ARE ENTERED FROM THE LINEAR REGRESSION PROGRAM, BY  *********
**********  SEASON AND TIME.  *******************************************
;
IF SEASON='SUMMER' AND TIME='AM' THEN DO;
FCST1=187 + 0.238*TEMP + 0.334*DEWPT - 0.188*QUAD - 0.059*SLP;
FCST2=130 + 0.487*TEMP + 0.165*DEWPT - 0.065*QUAD - 0.028*SLP;
FCST3=151 + 0.300*TEMP + 0.243*DEWPT - 0.180*QUAD - 0.016*SLP;
FCST4= 37 + 0.587*TEMP + 0.121*DEWPT - 0.153*QUAD + 0.048*SLP;
FCST5=154 + 0.174*TEMP + 0.268*DEWPT - 0.115*QUAD + 0.010*SLP;
END;
;
IF SEASON='SUMMER' AND TIME='PM' THEN DO;
FCST1=  54+ 0.451*TEMP + 0.263*DEWPT - 0.283*QUAD + 0.039*SLP;
FCST2=- 89+ 0.690*TEMP + 0.184*DEWPT - 0.186*QUAD + 0.130*SLP;
FCST3=  72+ 0.234*TEMP + 0.283*DEWPT - 0.229*QUAD + 0.079*SLP;
```

```
FCST4=   5+ 0.621*TEMP + 0.063*DEWPT - 0.096*QUAD + 0.091*SLP;
FCST5=   8+ 0.343*TEMP + 0.212*DEWPT - 0.298*QUAD + 0.131*SLP;
END;
;
IF SEASON='WINTER' AND TIME='AM' THEN DO;
FCST1= 64 + 0.389*TEMP + 0.494*DEWPT + 0.062*QUAD - 0.033*SLP;
FCST2= 32 + 0.464*TEMP + 0.455*DEWPT + 0.205*QUAD - 0.010*SLP;
FCST3= 66 + 0.255*TEMP + 0.481*DEWPT + 0.233*QUAD + 0.003*SLP;
FCST4= 31 + 0.484*TEMP + 0.251*DEWPT + 0.172*QUAD + 0.038*SLP;
FCST5= 33 + 0.346*TEMP + 0.374*DEWPT + 0.176*QUAD + 0.041*SLP;
END;
;
IF SEASON='WINTER' AND TIME='PM' THEN DO;
FCST1= 38 + 0.528*TEMP + 0.221*DEWPT - 0.008*QUAD + 0.031*SLP;
FCST2= 19 + 0.498*TEMP + 0.190*DEWPT + 0.014*QUAD + 0.066*SLP;
FCST3= 39 + 0.309*TEMP + 0.314*DEWPT + 0.164*QUAD + 0.063*SLP;
FCST4=-25 + 0.623*TEMP + 0.123*DEWPT + 0.193*QUAD + 0.091*SLP;
FCST5= 27 + 0.348*TEMP + 0.215*DEWPT + 0.155*QUAD + 0.090*SLP;
END;
;
**********  A RESIDUAL IS CALCULATED FORM THE ACTUAL TEMPERATURE  *******
**********  AND THE FORECASTED TEMPERATURE.  IF THE RESIDUAL IS LESS  ***
**********  THAN 2 DEG C. THEN THE FORECAST IS JUDGED CORRECT.  ********
;
R1=FCST1-TEMP;
R2=FCST2-TEMP;
R3=FCST3-TEMP;
R4=FCST4-TEMP;
R5=FCST5-TEMP;
;
ARRAY NUM R1-R5;
ARRAY NUMCOR N1-N5;
DO _I_ = 1 TO 5;
IF NUM=. THEN DELETE;
  IF ABS(NUM)<= 2 THEN NUMCOR=1;
    ELSE IF ABS(NUM) >2 THEN NUMCOR=0;
  SUM1=SUM(OF N1-N5);
END;
;
PROC SORT;
  BY MO TIME;
;
PROC PLOT;
  BY MO TIME;
  PLOT R1*DA='1'
       R2*DA='2'
       R3*DA='3'
       R4*DA='4'
       R5*DA='5'/VREF=2.0,-2 OVERLAY;
;
PROC SORT;
    BY MO TIME;
PROC MEANS NOPRINT;
  BY MO TIME;
  VAR N1-N5 SUM1;
  OUTPUT OUT=SET1 SUM=M1-M5 SUM1 N=P1-P5 SU1;
;
**********  A COUNT IS KEPT OF THE NUMBER OF CORRECT FORECASTS,  *******
**********  NUMBER OF INCORRECT FORECASTS, AND THE TOTAL NUMBER OF  ****
**********  FORECASTS.  THE PERCENT CORRECT (%) IS THEN OUTPUT.  *******
;
DATA FINAL;
  SET SET1;
  TOTFCSTS=SUM(OF P1-P5);
PROC SORT;
  BY MO TIME;
PROC MEANS NOPRINT;
  BY MO TIME;
  VAR TOTFCSTS;
  OUTPUT OUT=SET2 SUM=TOTFCSTS;
DATA PERCENT;
  MERGE SET1 SET2;
  BY MO TIME;
PCNTCOR=((SUM1)/TOTFCSTS)*100;
PROC SORT;
  BY MO TIME;
PROC PRINT;
  BY MO TIME;
  VAR SUM1 TOTFCSTS PCNTCOR;
```

A - 4

```
*******  THIS BLOCK OF CODE TAKES THE REGRESSION COEFFICIENT *******
*******  FROM THE PARTICULAR LAG AND ENTERS THEM AS CONSTANTS ******
*******  (OUTPUT IS FROM LINEAR REGRESSION PROGRAM).  THE TEST  ****
*******  RESTRICT PROCEDURE THEN COMPARES THE RESTRICTED MODEL *****
*******  USING THE CONSTANT REGRESSION COEFFICIENTS TO THE FULL ****
*******  MODEL.  AN F-STATISTIC IS GENERATED TO ALLOW DETERMIN- ****
*******  ATION OF WHICH SET OF COEFFICIENTS PROVIDE A BETTER  ******
*******  PREDICTOR (FULL VS REDUCED MODEL).   *********************
;
PROC REG DATA=L1;
  BY SEASON TIME;
  MODEL TEMP=T1 DP1 D1 P1;
  IF SEASON='SUMMER' AND TIME='AM' THEN
    RESTRICT T1=.22,DP1=.32,D1=-.18,P1=-.09;
  ELSE IF SEASON='SUMMER' AND TIME='PM' THEN
    RESTRICT T1=.46,DP1=.26,D1=-.27,P1=.05;
  ELSE DELETE;
```

A-5

```
**********    THIS SEQUENCE OF CODE USES CLIMATOLOGY, PERSISTENCE  *******
**********    AND THE AVERAGE OF CLIM. AND PERSIST. TO CALCULATE  ********
**********    THE  % CORRECT FORECASTS.  ******************************
;
****************    CLIMATOLOGICAL VALUES OF TEMPERATURE    ************
;
  IF MO=1 AND TIME='AM' THEN SAMC=266.5;
  ELSE IF MO=1 AND TIME='PM' THEN SAMC=270.2;
  ELSE IF MO=2 AND TIME='AM' THEN SAMC=266.1;
  ELSE IF MO=2 AND TIME='PM' THEN SAMC=270.9;
  ELSE IF MO=6 AND TIME='AM' THEN SAMC=291.6;
  ELSE IF MO=6 AND TIME='PM' THEN SAMC=300.1;
  ELSE IF MO=7 AND TIME='AM' THEN SAMC=293.8;
  ELSE IF MO=7 AND TIME='PM' THEN SAMC=303.0;
  ELSE IF MO=8 AND TIME='AM' THEN SAMC=291.7;
  ELSE IF MO=8 AND TIME='PM' THEN SAMC=301.5;
  ELSE IF MO=12 AND TIME='AM' THEN SAMC=270.1;
  ELSE IF MO=12 AND TIME='PM' THEN SAMC=272.7;
;
**********   THE DIF FUNCTION SERVES AS PERSITENCE.  DIF TAKES  **********
**********   THE FORECAST DAY'S TEMPERATURE AND CARRIES THE SAME  ********
**********   VALUE IN THE FUTURE.  RESIDUALS ARE COMPUTED FROM  **********
**********   THIS VALUE AND THE ACTUAL TEMPERATURE ON THAT LAG.  *********
;
  SAMP1=DIF1(TEMP);
  SAMP2=DIF2(TEMP);
  SAMP3=DIF3(TEMP);
  SAMP4=DIF4(TEMP);
  SAMP5=DIF5(TEMP);
;
***************    RESIDUALS OF CLIMATOLOGY ARE CALCULATED    ************
;
RR1=SAMC-TEMP;
RR2=SAMC-TEMP;
RR3=SAMC-TEMP;
RR4=SAMC-TEMP;
RR5=SAMC-TEMP;
;
*****  THE AVERAGE RESIDUALS OF CLIMO AND PERSISTENCE ARE CALCULATED  ***
;
R1=(RR1+SAMP1)/2;
R2=(RR2+SAMP2)/2;
R3=(RR3+SAMP3)/2;
R4=(RR4+SAMP4)/2;
R5=(RR5+SAMP5)/2;
;
ARRAY NUM R1-R5;
ARRAY NUMCOR N1-N5;
DO _I_ = 1 TO 5;
IF NUM=. THEN DELETE;
  IF ABS(NUM)<= 2 THEN NUMCOR=1;
    ELSE IF ABS(NUM) >2 THEN NUMCOR=0;
  SUM1=SUM(OF N1-N5);
END;
;
PROC SORT;
     BY MO TIME;
PROC MEANS NOPRINT;
  BY MO TIME;
  VAR N1-N5 SUM1;
  OUTPUT OUT=SET1 SUM=M1-M5 SUM1 N=P1-P5 SU1;
DATA FINAL.
  SET SET1;
  TOTFCSTS=SUM(OF P1-P5);
PROC SORT;
  BY MO TIME;
PROC MEANS NOPRINT;
  BY MO TIME;
  VAR TOTFCSTS;
  OUTPUT OUT=SET2 SUM=TOTFCSTS;
DATA PERCENT;
  MERGE SET1 SET2;  BY MO TIME;
PCNTCOR=((SUM1)/TOTFCSTS)*100;
PROC SORT;
  BY MO TIME;
PROC PRINT;
  BY MO TIME;
  VAR SUM1 TOTFCSTS PCNTCOR;
```

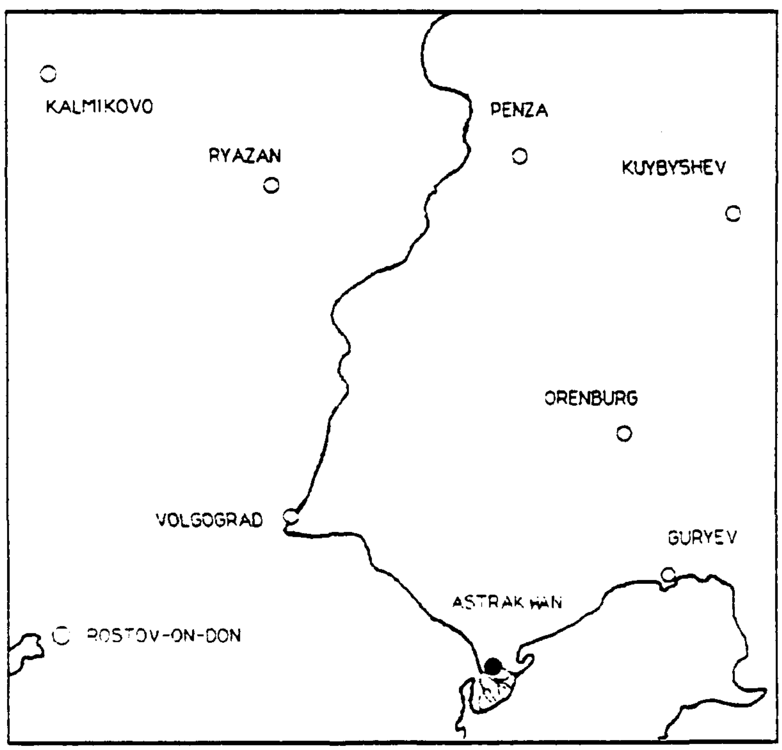
APPENDIX B

CLIMATOLOGICAL DATA FOR ASTRAKHAN, RS

STATION: ASTRAKHAN, RS

LOCATION: 46° 21' N 47° 59' E

ELEVATION: 18 m



CLIMATOLOGICAL TABLES FOR ASTRAKHAN, RS:

ASTRAKHAN, RS
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	304.0	303.0	295.2	290.5	304.0	301.9	302.2	308.0	299.2	297.2	300.5	298.2
		mean	266.5	266.1	271.3	279.7	287.1	291.6	293.8	291.7	285.9	279.0	274.4	270.1
		min	243.0	238.2	250.6	263.2	273.0	264.7	285.0	274.0	271.0	263.0	254.1	249.1
	afternoon	max	294.0	300.0	295.2	309.0	313.2	309.1	319.2	317.2	306.0	299.2	294.1	288.0
		mean	270.2	270.9	277.7	288.8	296.1	300.1	303.0	301.5	295.3	286.1	278.5	272.7
		min	250.8	250.8	252.2	270.8	275.2	269.0	290.5	246.2	279.2	249.2	258.3	251.9
T_d (K)	morning	max	278.3	278.0	281.9	286.9	291.9	295.8	298.6	303.2	293.2	293.2	284.2	281.2
		mean	264.8	264.1	269.3	276.3	282.4	286.3	288.3	286.8	282.7	276.8	272.6	268.5
		min	240.0	231.0	236.0	252.0	258.1	253.2	262.2	241.0	253.2	250.2	239.2	230.2
	afternoon	max	280.9	281.2	283.2	288.0	291.5	299.2	298.2	298.0	294.4	289.0	285.2	282.2
		mean	266.6	266.3	269.8	274.7	279.4	283.0	285.7	284.7	281.0	276.5	273.2	269.7
		min	233.0	243.0	229.2	256.9	253.0	249.0	270.0	253.0	265.0	234.2	225.0	238.0
RH	morning	mean	87	86	86	80	77	75	74	73	81	86	87	89
(%)	afternoon	mean	76	70	55	41	35	35	35	34	39	54	69	79
SLP (mb)	morning	max	1051.9	1065.4	1046.4	1038.5	1050.9	1025.3	1022.2	1025.4	1062.6	1041.0	1044.2	1051.9
		mean	1022.8	1022.4	1021.1	1015.8	1015.0	1011.4	1009.9	1012.2	1016.9	1020.9	1022.2	1022.0
		min	980.3	985.3	982.3	986.2	980.9	997.0	981.9	981.5	980.9	995.4	993.8	991.1
	afternoon	max	1054.5	1060.9	1047.5	1055.1	1032.9	1077.9	1078.6	1052.2	1077.4	1039.1	1067.4	1051.7
		mean	1022.6	1022.4	1021.2	1016.0	1015.1	1011.4	1010.0	1012.2	1016.9	1021.0	1022.3	1021.9
		min	990.9	985.5	985.4	980.9	982.2	975.7	981.2	973.4	975.9	985.2	986.2	985.5
R (mm)	monthly	max	33.0	33.0	50.8	43.2	61.0	48.3	61.0	73.7	50.8	53.3	50.8	50.8
		mean	12.7	12.7	10.2	15.2	15.2	20.3	12.7	10.2	15.2	10.2	15.2	15.2
		min	T	0.0	0.0	0.0	T	0.0	0.0	0.0	0.0	T	0.0	0.0
	24-hour	max	17.8	20.3	17.8	43.2	17.8	48.3	25.4	45.7	30.5	22.9	17.8	20.3

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	E,W/E,W	E,NE/E, W	E,W/E,W	E,NE/E, W	E,NE/E, W	W,NW/ W,E	W,NW/ W,E	NE,W/E, W	E,W/E, W	E,W/W,E	E,W/E,W	E,W/E,W
WND SP (kt)	am/pm	10/12	11/13	10/14	10/15	9/14	9/13	8/12	8/12	8/12	8/14	9/12	10/12
VIS (%)	am/pm												
[nm] < 0.5		7/ 3	7/2	6/1	3/1	1/1	1/*	1/*	1/1	5/*	7/1	8/1	10/4
0.5-1.5		4/ 6	4/6	4/3	3/1	1/*	1/*	*/*	*/*	2/*	2/1	3/4	4/7
1.5-3		15/20	15/16	19/9	12/5	4/1	3/*	2/*	4/*	9/1	10/5	14/13	16/20
>3		74/71	73/76	71/87	82/94	94/98	96/99	97/99	95/98	85/98	81/94	75/82	70/69
SKY (%)	am/pm												
PCLDY		37/34	42/37	43/36	51/39	59/47	65/53	71/64	71/63	68/60	54/47	36/30	28/26
MCLDY		14/29	15/30	16/37	28/42	28/41	27/41	22/30	22/31	19/31	20/37	19/35	15/29
OVC		42/35	35/32	34/27	20/19	13/11	8/7	7/7	6/7	11/9	23/16	39/34	46/40
OBSC		7/ 2	8/1	6/*	1/0	*/*	*/0	*/0	*/0	2/0	3/*	6/1	11/5
CIG (%)	am/pm												
HIGH		41/46	49/52	50/52	64/62	71/72	76/70	77/73	76/72	73/69	58/58	40/30	31/26
MIDDLE		12/15	12/14	15/16	23/20	23/18	21/18	21/18	21/19	18/20	17/16	13/16	10/14
LOW		47/40	40/34	36/32	13/18	5/10	3/11	2/9	2/9	8/11	25/26	47/44	59/50
WX (%)	am/pm												
DUST		1/*	1/1	*/1	*/2	*/1	*/*	0/0	*/*	0/*	*/*	0/*	*/*
HZ&SM		*/*	*/1	1/2	1/3	*/1	0/*	*/*	*/*	*/*	*/1	*/*	0/*
FOG		7/2	8/1	7/*	2/0	1/0	*/0	*/0	1/0	5/0	8/*	9/*	10/5
DRIZZLE		3/2	2/1	1/*	*/*	*/*	*/0	*/0	0/0	0/0	*/*	2/1	5/3
RAIN		1/1	1/1	3/2	4/4	3/2	2/1	1/1	1/1	2/2	4/2	4/4	2/2
SHOWERS		*/*	*/*	0/1	*/*	1/1	1/1	1/2	1/1	1/1	*/1	*/1	*/*
TSTMS		0/0	0/0	0/*	0/0	*/*	*/*	*/*	*/*	*/*	0/0	0/0	*/*
SNOW		7/8	8/8	5/3	*/*	0/0	0/0	0/0	0/0	0/0	*/1	2/2	*/0
NONE		80/85	80/86	82/91	91/90	94/95	96/97	98/97	97/97	92/97	88/95	83/91	76/82

LEGEND TO CLIMATE DATA

T: Temperature in degrees Kelvin (K).

Td: Dewpoint temperature in degrees Kelvin (K).
Mean morning = (04+07)/2 LST
Mean afternoon = (13+16)/2 LST
Max = highest value ever reported
Min = lowest value ever reported

RH = Relative humidity (%).

SLP = Sea level pressure in millibars (mb).

R = Precipitation in millimeters (mm)
T = trace

PVLG DD = Prevailing wind direction. The 2 most frequent wind directions are reported. If a direction is in **boldface type,** the frequency of % calm exceded the prevailing wind direction.

WND SP = Wind speed in knots (kt).

SKY = Sky cover by category in percent (%).

CIG = Ceiling height by category in percent (%).

WX = Weather occurrences by category in percent (%).

ASTRAKHAN, RS
AVERAGE TEMPERATURE CLIMATOLOGY
BY MONTH
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TEMPERATURE (K)											
extreme min	243.0	238.2	232.2	263.2	273.0	269.0	273.0	246.2	271.0	227.0	254.1	231.2
average temp	268.0	268.1	274.2	284.2	291.5	295.9	298.4	296.5	290.3	282.0	276.0	271.0
extreme max	289.0	290.1	304.2	309.0	313.2	309.1	319.2	317.2	313.2	304.0	301.0	290.0

Calculations based on a range of 5705-6200 observations per month with the exception of February which was based on 5577 observations.

Standard Deviation of data ranged from 2.5-6.5 K per month.

Coefficient of variation ranged from 1.6-2.4% per month.

ASTRAKHAN, RS
TEMPERATURE CLIMATOLOGY
BY MONTH AND PENTAD
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PENTAD	TEMPERATURE (K)											
1	269.5	267.2	269.9	280.9	288.8	294.6	298.0	297.8	293.7	284.6	277.9	272.3
2	269.1	266.8	271.1	282.7	290.3	295.5	298.6	297.6	292.1	283.8	276.2	272.0
3	267.7	268.2	272.9	283.6	291.8	296.0	298.2	297.7	290.4	283.4	276.7	270.6
4	267.7	268.8	274.9	284.7	292.2	295.9	298.7	296.4	289.5	281.4	275.9	271.4
5	266.1	269.1	276.4	285.5	292.4	296.2	298.8	295.8	288.8	280.1	275.3	269.0
6	267.8	269.0	279.1	287.8	293.3	297.1	298.0	294.4	287.1	279.6	274.1	270.7

EXTREME MINIMUM TEMPERATURE

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PENTAD	TEMPERATURE (K)											
1	250.0	243.0	232.2	265.4	273.0	279.1	286.9	284.1	280.2	263.2	262.0	253.4
2	251.2	238.2	251.9	265.8	276.9	279.0	287.0	274.0	279.0	270.2	259.0	240.0
3	247.2	248.0	256.9	269.1	279.1	284.1	273.0	268.0	273.2	270.8	261.0	250.8
4	248.0	250.2	256.9	263.2	278.2	284.1	285.2	278.2	273.0	267.0	262.4	255.8
5	243.0	254.8	260.8	271.9	275.2	275.2	286.9	283.0	275.0	266.2	257.5	253.0
6	246.0	254.0	263.0	272.0	280.8	286.9	286.9	286.2	271.0	264.1	254.1	251.2

EXTREME MAXIMUM TEMPERATURE

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
PENTAD	TEMPERATURE (K)											
1	293.0	286.0	293.2	295.0	302.2	308.0	312.2	317.2	306.0	299.2	300.5	288.0
2	300.2	304.2	303.0	309.0	304.1	309.1	311.0	315.2	305.8	298.0	298.2	284.6
3	284.0	293.0	304.2	300.2	310.0	308.0	312.2	310.2	303.6	297.0	288.5	299.2
4	305.0	293.0	293.2	304.2	313.2	308.0	319.2	310.8	302.0	299.0	304.0	298.2
5	295.2	303.0	295.2	299.1	306.4	309.1	315.2	312.0	305.2	297.2	287.0	294.2
6	295.2	285.0	304.2	308.2	308.0	309.1	310.8	315.2	313.2	301.0	301.2	299.0

Calculations based on a range of 925-1218 observations per month with the exception of February which was based on a range of 640-1009 observations.
Standard Deviation of data ranged from 2-7 K per cell.
Coefficient of variation ranged from 1.5-2.5% per cell.

ASTRAKHAN, RS
TEMPERATURE CLIMATOLOGY
BY HOUR AND MONTH
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HOUR (GMT)	TEMPERATURE (K)											
00	266.8	266.2	271.6	279.9	286.7	291.0	293.4	291.8	286.1	279.3	274.5	270.3
03	266.2	265.9	271.0	279.6	287.6	292.2	294.2	291.6	285.7	278.7	274.4	270.0
06	267.1	266.9	273.8	285.0	292.9	297.0	299.4	297.7	291.0	282.2	275.5	270.2
09	269.8	270.3	277.0	288.4	295.7	299.8	302.5	301.1	295.0	285.7	278.3	272.5
12	270.5	271.4	278.3	289.1	296.5	300.3	303.4	301.9	295.5	286.4	278.7	272.8
15	268.5	269.6	276.2	287.2	294.7	299.1	301.9	299.9	292.9	283.2	276.6	271.3
18	267.7	267.9	273.5	283.1	290.2	294.9	297.3	295.2	288.7	280.8	275.3	270.6
21	267.1	267.0	272.5	281.4	288.2	292.6	294.9	292.9	287.0	279.9	274.8	270.5

LST=GMT + 4.

Calculations based on a range of 680-801 observations per cell with the exception of February which was based on a range of 650-732 observations per cell.
Standard Deviation of data ranged from 4-6 K per cell.
Coefficient of Variation ranged from 1.5-2.6% per cell. The greatest variability in temperature occurred in winter. During the colder months, late night and early morning hours showed the greatest varibility. The morning and afternoon hours showed greatest variability during the warm months.

ASTRAKHAN, RS
AVERAGE SURFACE DEWPOINT TEMPERATURE
BY MONTH
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	DEWPOINT TEMPERATURE (K)											
extreme min	231.2	230.2	229.2	238.2	244.0	245.0	248.0	237.0	241.0	235.0	235.2	234.0
AVE DP	265.6	265.2	269.8	275.9	281.3	285.1	287.4	286.3	282.3	277.0	272.9	268.9
extreme max	280.9	281.2	293.2	291.2	293.2	302.2	299.1	303.2	295.5	293.2	285.2	282.2

Calculations based on a range of 5526-6152 observations per month.
Standard Deviation of data ranged from 4-6 K per month.
Coefficient of Variation ranged from 1.5-2.6% per month. The greatest variability in dewpoint during the winter months.

ASTRAKHAN, RS
RELATIVE HUMIDITY CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	RELATIVE HUMIDITY (%)											
00	84	84	75	74	74	74	73	72	80	85	83	87
06	86	81	72	54	47	47	47	51	61	73	83	85
12	70	70	46	35	37	34	38	33	37	50	67	69
18	82	75	80	62	59	59	58	61	71	79	84	82

LST+GMT+4

Calculations based on a range of 630-800 observations per cell.
Standard Deviation of data: 3% per cell.

RH=(e/e_s)x100 where e = saturation vapor pressure at dewpoint temperature and pressure and
e_s = saturation vapor pressure at dry-bulb temperature and pressure.
If temperature less than 0 °C then saturation vapor pressure was taken with respect to ice.

ASTRAKHAN, RS
AVERAGE SEA LEVEL PRESSURE CLIMATOLOGY
BY MONTH
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	SEA LEVEL PRESSURE (mb)											
extreme min	972.6	985.3	973.0	980.9	980.9	997.0	983.9	971.2	980.9	978.6	980.1	979.1
average pressure	1022.9	1022.5	1021.4	1016.5	1016.0	1013.0	1008.7	1016.7	1018.6	1021.3	1022.6	1022.2
extreme max	1054.5	1070.9	1088.3	1077.0	1050.9	1025.2	1020.7	1052.2	1082.6	1054.0	1067.4	1051.9

Calculations based on a range of 4609-5088 observations per month.
Standard Deviation of data ranged from 4.3-9.7 mb per month.
Coefficient of variation ranged from 0.4 -0.9 % per month. The greatest variability in SLP occurred during winter months.

ASTRAKHAN, RS
SEA LEVEL PRESSURE CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HOUR (GMT)	SEA LEVEL PRESSURE (mb)											
00	1022.9	1022.4	1021.1	1015.8	1014.9	1011.2	1009.6	1012.1	1016.9	1020.9	1022.3	1022.1
03	1022.7	1022.4	1021.1	1015.9	1015.1	1011.6	1010.2	1012.4	1017.0	1021.0	1022.1	1021.8
06	1023.4	1023.0	1021.8	1016.5	1015.6	1012.0	1010.6	1012.9	1017.6	1021.6	1022.8	1022.6
09	1023.1	1022.4	1021.6	1016.2	1015.3	1011.7	1010.3	1012.6	1017.2	1021.3	1022.5	1022.2
12	1022.2	1022.4	1020.8	1015.7	1014.9	1011.1	1009.7	1011.9	1016.6	1020.8	1022.2	1021.7
15	1022.7	1022.3	1021.3	1015.8	1014.5	1010.6	1009.1	1011.7	1016.4	1020.9	1022.8	1022.2
18	1023.0	1023.0	1021.7	1016.2	1015.1	1011.2	1010.0	1012.3	1017.2	1021.3	1022.8	1022.3
21	1023.0	1022.3	1021.4	1015.8	1015.1	1011.2	1009.9	1012.5	1017.2	1020.9	1022.9	1022.2

LST=GMT+4

Calculations based on a range of 580-649 observations per cell with the exception of February which was based on a range of 549-605 observations per cell.
Standard Deviation of data ranged from 4-9 mb per cell.
Coefficient of Variation ranged from 0.4-0.9% per cell.

ASTRAKHAN, RS
SEA LEVEL PRESSURE CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
HOUR (GMT)	SEA LEVEL PRESSURE (mb)											
00	1022.9	1022.4	1021.1	1015.8	1014.9	1011.2	1009.6	1012.1	1016.9	1020.9	1022.3	1022.1
03	1022.7	1022.4	1021.1	1015.9	1015.1	1011.6	1010.2	1012.4	1017.0	1021.0	1022.1	1021.8
06	1023.4	1023.0	1021.8	1016.5	1015.6	1012.0	1010.6	1012.9	1017.6	1021.6	1022.8	1022.6
09	1023.1	1022.4	1021.6	1016.2	1015.3	1011.7	1010.3	1012.6	1017.2	1021.3	1022.5	1022.2
12	1022.2	1022.4	1020.8	1015.7	1014.9	1011.1	1009.7	1011.9	1016.6	1020.8	1022.2	1021.7
15	1022.7	1022.3	1021.3	1015.8	1014.5	1010.6	1009.1	1011.7	1016.4	1020.9	1022.8	1022.2
18	1023.0	1023.0	1021.7	1016.2	1015.1	1011.2	1010.0	1012.3	1017.2	1021.3	1022.8	1022.3
21	1023.0	1022.3	1021.4	1015.8	1015.1	1011.2	1009.9	1012.5	1017.2	1020.9	1022.9	1022.2

LST=GMT+4

Calculations based on a range of 580-649 observations per cell with the exception of February which was based on a range of 549-605 observations per cell.
Standard Deviation of data ranged from 4-9 mb per cell.
Coefficient of Variation ranged from 0.4-0.9% per cell.

ASTRAKHAN, RS

PERCENTAGE OCCURRENCE OF WIND DIRECTION AND AVERAGE WIND SPEED CLIMATOLOGY BY MONTH

PERIOD OF RECORD. 1959-1986

WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
N	**2.9**	**3.4**	**4.0**	**3.7**	**4.2**	**5.0**	**6.3**	**5.1**	**3.9**	**3.2**	**3.2**	**1.9**
speed	8.8	8.9	8.3	9.3	9.3	9.0	8.4	9.0	8.1	8.0	8.4	8.1
NE	**10.4**	**12.8**	**10.2**	**10.3**	**10.1**	**6.2**	**6.4**	**8.8**	**7.4**	**7.5**	**10.3**	**10.2**
	8.8	9.4	9.4	9.5	9.5	8.9	8.3	8.2	7.8	8.2	7.6	7.9
E	**33.8**	**34.2**	**32.6**	**32.6**	**28.0**	**15.0**	**13.4**	**20.7**	**23.8**	**25.7**	**32.1**	**38.1**
	10.7	11.2	11.5	12.0	11.5	9.5	9.5	9.7	9.7	9.3	10.0	10.6
SE	**4.7**	**5.2**	**6.5**	**7.5**	**6.9**	**5.4**	**4.8**	**6.0**	**6.4**	**5.1**	**4.7**	**5.5**
	9.0	9.7	11.3	13.2	12.4	9.8	8.7	10.2	10.5	9.8	9.4	9.6
S	**7.4**	**7.9**	**7.6**	**9.5**	**10.7**	**13.3**	**12.0**	**10.0**	**9.8**	**8.7**	**7.6**	**8.0**
	9.1	9.2	9.5	10.6	9.4	9.3	8.4	8.5	8.2	8.5	8.7	8.8
SW	**5.0**	**3.4**	**3.5**	**3.1**	**3.8**	**6.9**	**6.0**	**4.5**	**5.3**	**5.6**	**4.9**	**3.7**
	11.1	11.7	10.3	9.3	9.7	9.3	8.7	8.7	9.5	10.5	10.2	10.0
W	**18.6**	**15.8**	**14.8**	**13.2**	**13.5**	**19.2**	**19.0**	**13.4**	**16.8**	**22.0**	**17.5**	**15.8**
	11.4	12.8	11.7	12.1	10.9	10.3	9.8	9.5	10.3	11.4	11.6	11.6
NW	**7.5**	**8.5**	**10.8**	**9.4**	**10.3**	**12.9**	**12.9**	**12.0**	**9.7**	**7.8**	**7.6**	**5.8**
	9.6	10.6	10.6	10.7	9.4	9.3	8.7	8.9	9.1	9.5	10.3	9.6
calm	**9.8**	**8.8**	**9.9**	**10.6**	**12.5**	**16.1**	**19.0**	**19.5**	**16.9**	**14.4**	**12.1**	**11.0**

Calculations based on a range of 5446-5780 observations per month with the exception of February which was based on 5369 observations. Standard Deviation of wind speed data ranged from 3.3-7.1 kts per cell.
Standard Deviation of percentages: 2% per cell. Coefficient of variation of wind speed ranged from 41-76% per cell.

MONTH	HIGHEST RECORDED WIND SPEED (KTS)
JANUARY	77.7 [NE and E]
FEBRUARY	87.2 [E]
MARCH	97.2 [E]
APRIL	91.3 [W]
MAY	89.4 [E]
JUNE	97.2 [SW]
JULY	93.3 [S]
AUGUST	97.2 [S and SW]
SEPTEMBER	75.8 [NW]
OCTOBER	79.7 [NE]
NOVEMBER	39.1 [NW]
DECEMBER	67.1 [SE]

ASTRAKHAN, RS
PERCENT OCCURRENCE OF WIND DIRECTION AND AVERAGE WIND SPEED CLIMATOLOGY BY MONTH AND PENTAD
PERIOD OF RECORD: 1959-1986

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**1.9**	**2.3**	**4.6**	**3.4**	**3.1**	**6.7**	**4.9**	**5.9**	**3.7**	**3.7**	**4.9**	**1.7**
speed		8.9	8.0	7.8	8.7	9.2	10.4	8.4	9.5	7.8	7.7	10.7	8.3
	NE	**8.3**	**15.2**	**11.3**	**9.8**	**8.8**	**9.5**	**5.7**	**8.1**	**12.9**	**8.8**	**11.3**	**8.1**
		7.4	9.6	8.5	9.4	9.6	10.8	7.1	8.6	7.9	8.2	6.9	8.6
	E	**33.0**	**34.7**	**36.8**	**39.6**	**28.6**	**20.2**	**13.9**	**14.9**	**31.5**	**31.7**	**19.2**	**32.7**
		10.7	10.4	11.3	11.8	12.4	10.5	9.4	9.2	10.2	10.4	9.4	10.8
	SE	**7.2**	**6.7**	**5.5**	**8.4**	**8.9**	**5.5**	**5.1**	**4.1**	**7.2**	**4.9**	**3.8**	**5.0**
		10.1	9.7	8.4	13.6	13.4	10.7	9.8	9.8	9.9	9.4	7.9	10.1
	S	**8.8**	**9.1**	**5.1**	**8.9**	**7.7**	**11.7**	**12.4**	**10.3**	**9.2**	**6.7**	**8.2**	**7.8**
		8.7	7.9	8.8	12.6	9.9	9.4	9.0	8.3	7.7	7.5	9.4	8.4
	SW	**5.2**	**3.5**	**2.6**	**2.2**	**3.5**	**6.3**	**8.0**	**6.6**	**2.9**	**3.8**	**6.4**	**6.2**
		10.3	11.6	8.1	9.4	8.7	9.9	9.1	8.3	10.3	11.0	10.9	10.8
	W	**19.1**	**12.6**	**12.2**	**10.2**	**16.4**	**12.9**	**17.6**	**17.0**	**9.7**	**15.9**	**22.8**	**20.3**
		11.4	13.8	11.3	12.1	10.8	11.2	10.3	9.3	11.3	12.1	11.3	12.7
	NW	**6.3**	**5.3**	**9.9**	**9.0**	**11.7**	**11.6**	**13.0**	**14.7**	**8.3**	**8.1**	**10.0**	**7.4**
		8.8	9.8	9.9	13.3	9.4	9.4	8.9	9.1	9.5	9.0	10.6	9.7
	calm	**10.2**	**10.6**	**11.9**	**8.4**	**11.1**	**15.5**	**19.3**	**18.3**	**14.7**	**16.3**	**13.4**	**10.7**

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.3**	**4.6**	**4.0**	**2.0**	**3.9**	**5.2**	**7.5**	**5.7**	**4.8**	**2.3**	**1.9**	**1.9**
speed		8.8	9.8	8.4	8.6	7.7	8.2	8.6	9.7	8.6	7.9	6.8	10.1
	NE	**9.8**	**12.0**	**13.1**	**9.4**	**11.2**	**5.3**	**5.5**	**6.8**	**7.3**	**7.2**	**11.8**	**9.3**
		9.3	9.0	10.3	9.3	9.6	8.9	7.8	8.1	7.7	8.0	7.5	7.4
	E	**32.6**	**31.6**	**28.7**	**40.6**	**33.1**	**17.6**	**13.1**	**20.6**	**23.8**	**32.6**	**38.1**	**32.6**
		10.2	10.9	11.7	12.0	11.8	9.5	10.8	9.8	10.1	9.2	9.7	10.3
	SE	**3.4**	**5.3**	**6.2**	**7.7**	**6.4**	**6.5**	**4.3**	**4.8**	**6.2**	**5.7**	**2.9**	**6.5**
		9.1	9.6	10.6	11.6	12.5	9.4	8.5	10.3	11.1	11.9	9.2	9.9
	S	**8.0**	**10.0**	**10.4**	**7.5**	**10.7**	**12.9**	**12.0**	**9.5**	**9.9**	**8.0**	**4.3**	**11.2**
		8.0	10.7	10.1	11.6	8.2	8.9	9.0	8.0	8.7	9.6	9.9	8.4
	SW	**4.9**	**5.3**	**4.3**	**3.1**	**4.2**	**7.0**	**7.1**	**4.5**	**4.1**	**5.0**	**4.5**	**6.4**
		11.6	14.9	12.5	9.5	8.5	9.6	9.1	8.5	9.1	9.1	10.6	9.9
	W	**19.0**	**20.4**	**15.0**	**14.1**	**9.1**	**19.9**	**19.6**	**13.8**	**14.5**	**21.4**	**17.8**	**15.5**
		13.2	14.7	13.1	12.3	11.7	10.2	10.1	9.8	9.4	13.0	11.8	10.8
	NW	**7.5**	**4.7**	**10.7**	**8.5**	**7.5**	**11.1**	**15.0**	**13.3**	**9.8**	**5.0**	**7.6**	**4.4**
		9.7	9.7	11.5	10.5	8.1	9.5	8.9	8.5	9.3	9.2	9.0	11.0
	calm	**11.4**	**16.1**	**7.6**	**7.2**	**14.0**	**14.5**	**15.9**	**21.0**	**19.7**	**12.8**	**11.0**	**12.1**

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.2**	**4.6**	**6.2**	**3.3**	**2.6**	**3.2**	**5.2**	**5.0**	**4.9**	**2.2**	**2.9**	**2.6**
speed		9.0	9.7	8.1	10.3	12.4	8.9	8.5	8.6	8.0	9.0	7.3	9.3
	NE	**12.7**	**13.2**	**9.5**	**11.4**	**11.5**	**6.5**	**8.0**	**9.2**	**5.6**	**6.3**	**10.5**	**11.2**
		8.4	8.8	9.1	9.3	10.7	8.4	9.6	7.5	7.3	7.5	7.3	7.7
	E	**28.6**	**29.2**	**25.0**	**32.0**	**35.6**	**19.4**	**12.3**	**18.8**	**16.2**	**22.4**	**28.6**	**40.9**
		9.8	11.1	11.0	11.3	11.8	9.5	9.9	9.3	9.1	9.0	10.0	10.4
	SE	**6.1**	**8.1**	**7.2**	**6.2**	**10.5**	**6.4**	**4.1**	**7.7**	**5.2**	**5.2**	**5.6**	**5.0**
		8.3	9.2	11.3	12.6	13.8	11.1	9.2	9.5	10.5	10.2	9.0	8.9
	S	**8.2**	**10.4**	**6.2**	**11.3**	**9.2**	**14.2**	**12.0**	**11.5**	**8.9**	**9.0**	**10.7**	**6.3**
		9.4	9.6	10.1	9.4	10.4	9.3	8.3	8.5	8.2	9.5	8.7	8.1
	SW	**3.6**	**2.6**	**4.7**	**1.9**	**3.4**	**6.3**	**5.1**	**4.4**	**6.4**	**4.0**	**6.5**	**1.9**
		10.9	7.6	11.3	7.9	8.5	11.4	7.9	7.5	9.9	9.8	9.4	8.8
	W	**18.9**	**13.6**	**16.4**	**11.0**	**11.5**	**18.1**	**23.1**	**11.5**	**21.4**	**26.3**	**17.2**	**14.4**
		11.4	11.5	12.1	10.5	10.7	10.5	9.8	9.6	9.7	11.0	11.8	10.1
	NW	**9.8**	**8.7**	**14.0**	**10.2**	**6.9**	**11.4**	**10.8**	**11.6**	**12.3**	**8.1**	**8.6**	**8.4**
		9.8	8.8	11.9	8.9	10.2	9.5	8.9	9.1	9.3	9.4	9.8	9.3
	calm	**8.9**	**9.6**	**10.9**	**12.8**	**8.8**	**14.5**	**19.1**	**20.2**	**19.0**	**16.4**	**9.5**	**9.3**

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
4		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.7**	**3.0**	**2.2**	**4.8**	**4.4**	**5.0**	**6.1**	**5.3**	**3.3**	**3.7**	**3.3**	**1.3**
speed		8.4	8.0	9.9	8.5	8.2	9.0	7.4	7.8	7.1	7.1	7.2	5.1
	NE	**8.6**	**10.5**	**11.0**	**9.2**	**9.4**	**6.2**	**6.8**	**8.8**	**6.1**	**7.8**	**9.5**	**11.4**
		10.7	8.1	11.0	9.3	8.9	7.6	8.0	8.7	8.5	8.6	9.1	7.7
	E	**34.5**	**39.7**	**34.7**	**23.6**	**22.9**	**10.2**	**12.7**	**16.9**	**18.6**	**19.9**	**39.7**	**40.5**
		11.5	12.2	10.8	11.8	10.8	8.3	8.3	9.1	8.7	8.6	10.9	10.3
	SE	**3.5**	**3.0**	**7.7**	**8.2**	**4.9**	**4.6**	**4.4**	**5.3**	**5.5**	**6.8**	**6.5**	**5.3**
		8.1	10.8	12.9	13.1	8.9	8.7	8.1	9.5	10.3	8.4	9.0	10.4
	S	**7.6**	**4.7**	**7.8**	**9.9**	**13.8**	**12.3**	**10.7**	**12.3**	**12.5**	**11.8**	**8.8**	**6.2**
		9.3	8.4	10.0	10.3	9.4	9.1	7.9	8.1	7.8	8.3	8.9	9.8
	SW	**3.8**	**2.3**	**2.8**	**4.9**	**4.6**	**6.5**	**6.4**	**3.2**	**6.5**	**5.7**	**2.6**	**2.1**
		8.4	10.7	8.2	10.3	10.5	8.0	8.8	7.9	9.6	10.7	9.5	9.8
	W	**18.8**	**16.4**	**15.8**	**14.3**	**16.9**	**22.0**	**21.7**	**14.3**	**19.5**	**20.5**	**13.7**	**14.9**
		11.0	11.3	11.7	13.2	11.9	10.0	10.1	8.5	10.0	10.2	10.7	11.6
	NW	**9.6**	**11.4**	**8.5**	**10.8**	**10.7**	**15.6**	**12.8**	**12.0**	**11.5**	**7.9**	**3.9**	**4.6**
		9.7	10.6	10.7	11.0	9.2	8.9	7.8	8.6	8.4	10.3	10.5	8.4
	calm	**10.0**	**8.8**	**9.4**	**14.3**	**12.2**	**17.5**	**18.3**	**21.9**	**16.5**	**15.9**	**12.1**	**13.7**

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.3**	**2.5**	**4.3**	**3.8**	**6.7**	**4.9**	**7.6**	**4.5**	**3.5**	**3.7**	**2.6**	**2.0**
speed		9.4	9.2	9.1	10.8	10.2	9.0	8.6	8.9	9.1	8.6	7.5	6.0
	NE	**12.2**	**13.6**	**10.2**	**11.5**	**9.8**	**5.2**	**5.2**	**9.9**	**6.9**	**8.7**	**10.7**	**10.0**
		8.5	11.2	8.6	9.7	9.0	9.1	7.9	7.4	7.2	8.5	7.6	7.7
	E	**33.0**	**33.0**	**29.9**	**27.8**	**24.5**	**9.5**	**15.8**	**25.3**	**25.5**	**5.8**	**37.5**	**42.5**
		10.3	11.4	12.1	13.4	10.5	9.2	9.0	9.7	9.7	9.5	10.0	10.9
	SE	**4.8**	**4.0**	**6.2**	**6.5**	**5.6**	**4.1**	**5.9**	**8.6**	**7.8**	**3.1**	**3.6**	**3.7**
		9.0	9.4	11.0	11.6	10.5	8.5	8.4	11.6	11.7	9.9	9.3	9.1
	S	**5.9**	**7.9**	**6.9**	**10.5**	**12.3**	**13.0**	**13.0**	**7.0**	**10.4**	**7.3**	**7.0**	**6.1**
		9.0	8.9	8.0	9.2	9.1	9.5	8.5	8.5	8.9	6.9	8.2	9.2
	SW	**5.6**	**3.6**	**3.4**	**3.3**	**3.3**	**7.8**	**4.8**	**3.7**	**5.5**	**6.5**	**4.1**	**3.0**
		12.1	10.6	9.8	8.9	9.3	8.7	8.2	10.9	8.5	10.7	10.7	10.1
	W	**19.3**	**15.3**	**16.5**	**14.0**	**11.3**	**25.9**	**14.1**	**10.9**	**15.6**	**22.5**	**16.2**	**17.8**
		10.8	12.6	11.4	12.5	9.7	10.7	8.3	10.1	11.0	11.4	11.9	12.4
	NW	**6.2**	**10.3**	**11.9**	**10.2**	**12.0**	**16.2**	**12.9**	**10.7**	**8.6**	**10.1**	**5.9**	**6.1**
		10.1	12.2	10.1	10.0	9.8	8.4	8.6	9.0	10.1	9.3	10.5	10.5
	calm	**9.7**	**9.7**	**10.7**	**12.3**	**14.5**	**13.5**	**20.7**	**19.5**	**16.3**	**12.3**	**12.5**	**8.7**

pen-tad	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
6		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	1.7	3.4	2.4	4.6	4.4	5.0	6.7	4.2	3.1	3.3	3.5	1.5
speed		7.6	7.2	6.4	9.1	8.7	8.4	8.9	9.1	7.9	7.9	8.5	8.8
	NE	10.8	12.1	6.3	10.5	9.9	4.6	7.4	10.2	6.0	6.6	8.0	11.0
		8.6	9.1	8.2	9.8	9.0	7.7	8.6	8.7	8.1	8.0	7.3	8.5
	E	40.9	38.5	40.4	31.8	23.3	13.0	12.5	27.7	27.6	21.8	29.6	39.6
		11.2	11.4	12.1	11.7	11.1	9.5	10.1	10.4	10.1	8.4	9.5	10.9
	SE	3.3	2.9	6.2	8.4	5.0	5.3	4.9	5.2	6.7	5.0	5.8	7.6
		8.4	11.7	12.7	15.8	12.9	10.0	8.3	9.9	9.0	9.3	11.2	9.2
	S	5.8	3.9	9.4	9.1	10.2	15.6	12.0	9.5	8.0	9.0	6.5	10.4
		10.7	9.4	9.5	11.1	9.7	9.7	8.0	9.4	8.0	8.7	7.2	9.1
	SW	6.9	3.2	3.2	3.4	3.7	7.3	4.7	4.5	6.6	8.6	5.5	2.6
		12.2	11.3	9.8	9.0	12.4	8.6	8.1	9.3	9.8	11.3	10.1	9.1
	W	16.6	16.3	13.1	15.7	15.8	16.6	17.8	12.5	19.5	25.1	17.3	11.7
		10.8	12.0	10.5	11.9	10.5	9.3	9.5	9.9	10.8	11.0	12.2	11.6
	NW	5.6	11.7	10.1	7.4	13.3	11.5	12.9	10.1	7.3	7.9	9.8	3.8
		9.3	11.6	9.2	10.9	9.5	10.2	9.0	8.9	8.0	9.6	11.1	8.4
	calm	8.3	7.9	8.9	9.0	14.3	21.1	21.1	16.1	15.2	12.6	13.9	11.7

ASTRAKHAN, RS
PERCENTAGE OCCURRENCE OF WIND DIRECTION AND AVERAGE WIND SPEED CLIMATOLOGY BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
00		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**2.3**	**2.6**	**4.6**	**3.8**	**4.6**	**3.7**	**4.7**	**4.3**	**3.5**	**3.1**	**3.4**	**1.0**
speed		8.4	8.4	7.4	8.6	9.9	7.4	7.6	9.2	9.0	7.5	7.6	8.2
	NE	**11.7**	**15.4**	**12.1**	**15.8**	**12.1**	**7.5**	**7.1**	**15.4**	**12.4**	**10.2**	**11.8**	**11.1**
		8.2	8.8	9.3	8.6	8.8	8.1	7.5	7.4	7.8	7.8	7.3	7.6
	E	**31.8**	**29.5**	**31.3**	**29.8**	**31.3**	**9.8**	**7.0**	**10.9**	**19.5**	**24.1**	**29.1**	**37.6**
		10.1	10.7	10.0	9.8	8.6	7.0	7.0	7.5	8.2	7.8	9.2	10.2
	SE	**4.3**	**4.9**	**3.0**	**2.5**	**3.0**	**1.8**	**1.4**	**1.5**	**2.8**	**2.4**	**3.7**	**5.1**
		8.6	8.8	9.5	7.6	6.5	4.6	13.5	7.0	6.4	8.1	8.0	8.2
	S	**5.9**	**8.5**	**6.9**	**5.7**	**6.9**	**6.0**	**5.3**	**5.2**	**6.0**	**5.3**	**5.5**	**6.8**
		8.4	8.5	8.7	7.8	6.2	6.5	6.2	5.7	6.5	7.1	8.0	8.0
	SW	**5.7**	**2.9**	**3.2**	**3.5**	**3.2**	**5.6**	**5.5**	**1.7**	**4.2**	**5.6**	**4.8**	**3.4**
		10.5	10.5	8.1	8.1	8.9	7.2	7.0	6.5	9.7	10.4	9.4	11.2
	W	**17.8**	**14.9**	**15.5**	**11.7**	**15.5**	**20.9**	**19.2**	**15.1**	**15.3**	**20.7**	**17.2**	**14.5**
		11.4	12.2	11.0	11.3	9.1	8.7	7.9	8.2	8.9	10.1	11.2	11.0
	NW	**7.7**	**8.0**	**8.6**	**9.2**	**8.6**	**13.3**	**15.7**	**13.3**	**8.3**	**6.3**	**6.9**	**6.4**
		8.9	10.7	9.8	9.0	8.3	7.7	7.1	7.4	8.2	9.1	9.9	9.6
	calm	**12.7**	**13.3**	**14.8**	**17.9**	**14.8**	**31.4**	**33.9**	**32.5**	**27.9**	**22.3**	**17.8**	**14.1**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 3		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.6**	**3.4**	**3.2**	**5.3**	**3.2**	**4.1**	**5.3**	**5.3**	**3.0**	**3.3**	**3.8**	**2.3**
speed		8.1	8.5	8.1	7.3	8.0	6.9	6.6	7.3	8.4	6.8	7.7	8.5
	NE	**13.1**	**17.0**	**12.1**	**16.4**	**12.1**	**11.2**	**12.5**	**17.3**	**14.2**	**10.8**	**13.6**	**13.0**
		8.1	8.3	9.0	9.3	8.7	9.9	8.5	8.0	7.7	8.6	7.2	7.9
	E	**31.7**	**32.2**	**32.5**	**29.6**	**32.5**	**12.1**	**8.4**	**14.3**	**20.3**	**25.7**	**28.7**	**36.5**
		10.0	10.3	10.2	10.0	9.2	7.8	7.4	7.9	8.1	7.5	9.4	9.9
	SE	**2.9**	**3.7**	**4.2**	**4.1**	**4.2**	**1.0**	**1.1**	**1.9**	**2.0**	**1.7**	**3.0**	**4.1**
		9.1	8.5	9.7	8.2	8.2	7.8	5.4	4.5	8.4	8.3	8.4	8.3
	S	**7.3**	**7.4**	**6.2**	**5.5**	**6.2**	**5.7**	**4.0**	**3.7**	**6.1**	**5.5**	**4.7**	**7.2**
		8.3	8.6	8.1	8.1	7.5	7.6	6.1	7.2	6.0	6.3	7.5	8.2
	SW	**3.8**	**3.1**	**3.2**	**2.8**	**3.2**	**3.4**	**3.7**	**2.8**	**5.7**	**5.8**	**4.4**	**2.8**
		10.7	11.9	10.1	9.6	8.9	7.0	8.4	6.9	10.5	10.7	9.8	9.1
	W	**18.4**	**15.6**	**12.5**	**12.5**	**12.5**	**24.5**	**20.9**	**12.9**	**14.0**	**21.0**	**18.5**	**15.8**
		11.1	12.6	12.2	10.2	10.5	8.7	8.6	7.5	8.0	10.1	11.2	12.0
	NW	**7.2**	**6.9**	**10.2**	**7.7**	**10.2**	**14.9**	**17.2**	**11.2**	**8.8**	**6.9**	**6.4**	5.9
		9.4	9.6	9.2	8.9	8.5	7.6	7.2	8.1	7.9	8.2	10.2	9.5
	calm	**12.0**	**10.7**	**15.8**	**16.1**	**15.8**	**23.1**	**26.8**	**30.6**	**25.8**	**19.4**	**16.9**	**12.3**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
06		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**2.0**	**3.3**	**3.3**	**3.5**	**3.3**	**4.6**	**6.7**	**5.0**	**3.7**	**3.3**	**3.8**	**1.6**
speed		10.9	10.5	8.2	10.9	9.6	9.9	8.5	8.4	7.8	9.0	8.3	8.1
	NE	**11.3**	**13.9**	**11.2**	**11.1**	**11.2**	**8.3**	**10.8**	**11.6**	**6.7**	**7.1**	**12.0**	**9.8**
		9.1	9.9	9.5	10.6	10.6	9.2	8.6	8.8	7.7	8.7	7.8	8.1
	E	**36.0**	**33.5**	**34.2**	**36.8**	**34.2**	**19.3**	**18.2**	**27.9**	**29.4**	**28.3**	**32.3**	**37.5**
		10.4	11.3	12.1	13.1	13.1	11.1	10.2	10.1	11.4	10.3	10.3	11.0
	SE	**4.1**	**5.3**	**5.2**	**8.7**	**5.2**	**5.0**	**3.7**	**4.3**	**6.1**	**4.5**	**4.7**	**4.8**
		7.6	10.0	11.8	15.5	15.0	11.2	8.3	13.4	10.5	9.5	8.5	9.8
	S	**7.6**	**8.8**	**7.8**	**6.9**	**7.8**	**7.1**	**6.4**	**5.6**	**7.5**	**6.7**	**6.8**	**8.0**
		8.4	8.6	10.5	11.9	10.9	9.9	8.2	8.3	9.7	8.5	8.4	9.1
	SW	**5.4**	**3.3**	**4.1**	**2.2**	**4.1**	**7.2**	**4.5**	**3.8**	**6.6**	**6.3**	**5.8**	**4.0**
		11.4	11.6	10.6	8.4	10.2	8.6	9.2	8.7	9.1	11.5	11.2	10.5
	W	**16.9**	**15.4**	**14.0**	**14.8**	**14.0**	**23.3**	**23.1**	**16.3**	**17.1**	**23.6**	**16.1**	**14.8**
		10.9	13.0	12.4	12.7	11.5	10.9	10.0	9.1	10.5	11.4	12.6	11.3
	NW	**6.7**	**8.2**	**11.6**	**9.9**	**11.6**	**16.2**	**14.7**	**13.3**	**10.8**	**7.7**	**7.3**	**6.1**
		9.0	10.2	10.0	10.1	9.6	9.6	9.4	9.2	8.7	9.2	9.4	9.4
	calm	**9.9**	**8.2**	**8.6**	**6.0**	**8.6**	**9.1**	**11.8**	**12.1**	**12.0**	**12.4**	**11.1**	**13.4**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
09		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.1**	**2.2**	**2.7**	**2.4**	**2.7**	**4.7**	**8.6**	**6.2**	**4.1**	**4.0**	**2.8**	**1.7**
speed		8.9	9.6	9.0	11.9	10.3	11.0	10.2	10.7	7.9	8.8	9.7	10.2
	NE	**7.6**	**9.9**	**8.1**	**8.7**	**8.1**	**6.2**	**6.4**	**6.5**	**4.9**	**4.0**	**7.2**	**8.1**
		9.1	10.8	10.7	10.9	11.4	10.4	8.8	10.0	8.6	8.9	8.8	8.4
	E	**33.1**	**34.9**	**33.7**	**35.0**	**33.7**	**19.0**	**19.6**	**26.7**	**25.7**	**25.2**	**32.5**	**36.7**
		12.1	13.0	13.5	14.9	14.8	11.8	11.6	11.7	12.3	12.5	12.0	11.4
	SE	**5.6**	**7.6**	**9.0**	**11.0**	**9.0**	**6.5**	**5.3**	**9.7**	**11.3**	**8.7**	**6.7**	**9.3**
		10.4	11.1	14.4	16.6	15.4	13.1	9.7	11.8	12.7	11.9	12.0	10.5
	S	**10.1**	**8.1**	**7.4**	**9.9**	**7.4**	**14.1**	**10.3**	**10.0**	**9.0**	**10.7**	**8.9**	**7.9**
		10.1	10.3	12.6	14.3	11.3	10.3	9.7	9.9	9.6	9.8	9.9	10.0
	SW	**5.8**	**5.1**	**4.1**	**3.7**	**4.1**	**9.9**	**7.5**	**6.3**	**7.9**	**6.9**	**5.8**	**5.0**
		12.7	13.0	12.5	11.0	11.3	10.5	10.4	9.1	10.5	12.1	11.1	10.3
	W	**21.5**	**15.8**	**16.7**	**16.6**	**16.7**	**22.8**	**23.7**	**17.8**	**20.9**	**26.1**	**19.2**	**18.0**
		12.4	14.0	12.8	13.4	13.2	12.2	11.8	11.6	12.4	13.7	13.6	12.0
	NW	**7.8**	**10.5**	**13.6**	**9.0**	**13.6**	**10.8**	**12.9**	**11.6**	**10.9**	**8.6**	**8.6**	**5.6**
		11.0	11.2	11.9	12.3	10.8	10.9	10.1	10.2	9.9	11.1	10.7	9.3
	calm	**5.4**	**5.9**	**4.6**	**3.7**	**4.6**	**5.9**	**5.6**	**5.1**	**5.3**	**5.8**	**8.3**	**7.6**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1 2		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.4**	**4.4**	**4.8**	**3.5**	**4.8**	**6.5**	**9.1**	**5.0**	**5.5**	**2.1**	**2.6**	**2.6**
speed		10.0	9.4	8.4	11.9	11.3	10.7	9.2	10.3	9.1	8.6	9.2	9.1
	NE	**9.0**	**9.8**	**7.2**	**5.4**	**7.2**	**4.0**	**4.0**	**3.6**	**3.5**	**5.3**	**8.1**	**9.1**
		10.6	10.6	10.1	10.7	10.7	9.1	9.4	10.5	11.1	9.8	8.7	8.5
	E	**34.7**	**36.7**	**32.4**	**34.4**	**32.4**	**19.9**	**19.9**	**26.5**	**23.7**	**23.3**	**34.9**	**40.2**
		11.9	12.3	14.5	15.0	14.2	11.1	11.1	11.4	12.6	12.7	11.3	11.7
	SE	**4.6**	**5.4**	**9.9**	**10.7**	**9.8**	**9.0**	**8.5**	**11.6**	**10.8**	**9.6**	**6.4**	**5.3**
		11.1	11.3	13.7	17.1	14.7	12.4	10.3	12.0	14.0	13.3	11.8	10.5
	S	**8.6**	**7.4**	**8.8**	**12.7**	**8.8**	**17.7**	**15.0**	**12.2**	**11.9**	**9.2**	**7.9**	**7.7**
		10.5	11.3	11.0	12.7	11.9	11.8	10.5	10.1	10.4	10.7	10.4	9.5
	SW	**4.7**	**3.0**	**4.3**	**3.6**	**4.3**	**9.1**	**8.8**	**7.1**	**5.9**	**6.2**	**5.0**	**4.2**
		12.3	12.8	11.8	11.1	10.8	12.1	10.1	9.9	10.7	10.4	10.9	9.7
	W	**19.7**	**18.1**	**17.2**	**15.4**	**17.2**	**19.1**	**19.6**	**15.6**	**21.1**	**26.6**	**19.9**	**17.5**
		11.7	13.8	13.2	15.1	12.8	13.3	12.4	11.9	13.1	13.5	12.7	12.3
	NW	**8.7**	**10.8**	**12.1**	**11.2**	**12.1**	**10.9**	**9.5**	**11.9**	**11.9**	**10.5**	**9.8**	**6.3**
		11.0	11.4	12.0	12.6	11.1	12.1	10.8	10.6	10.7	10.3	10.1	9.6
	calm	**6.6**	**4.5**	**3.4**	**3.1**	**3.5**	**3.7**	**5.6**	**6.4**	**5.5**	**7.2**	**5.3**	**7.1**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
15		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**3.5**	**4.3**	**5.9**	**3.8**	**5.9**	**7.3**	**9.1**	**7.3**	**4.3**	**3.7**	**3.6**	**1.9**
speed		9.2	9.9	8.9	10.0	9.1	9.9	8.3	9.3	7.1	7.4	8.6	7.4
	NE	**9.2**	**10.9**	**7.4**	**5.2**	**7.4**	**3.3**	**3.2**	**4.1**	**2.9**	**6.1**	**7.5**	**10.2**
		9.1	9.6	9.0	10.2	11.3	7.5	10.1	7.9	8.5	7.3	8.0	7.6
	E	**33.8**	**36.4**	**34.9**	**34.1**	**34.9**	**17.9**	**17.3**	**26.9**	**27.2**	**27.3**	**36.4**	**40.6**
		10.5	11.1	11.9	12.9	12.5	10.6	10.1	10.2	9.1	8.7	9.3	10.5
	SE	**5.1**	**4.3**	**8.6**	**12.6**	**8.6**	**11.7**	**11.1**	**11.2**	**10.1**	**6.9**	**4.6**	**4.0**
		8.8	9.1	11.0	12.9	11.9	9.7	9.1	9.5	9.2	7.2	7.7	9.8
	S	**6.6**	**7.9**	**8.1**	**14.1**	**8.1**	**22.4**	**22.0**	**16.8**	**14.5**	**11.7**	**8.7**	**8.5**
		9.3	9.0	9.4	12.5	10.5	10.9	10.7	9.7	8.4	8.5	9.0	8.2
	SW	**4.9**	**2.9**	**2.1**	**3.1**	**2.1**	**6.7**	**4.7**	**4.5**	**4.6**	**4.5**	**5.2**	**3.3**
		8.7	12.8	9.3	10.6	10.0	10.5	8.4	8.3	8.2	9.2	9.5	10.0
	W	**19.1**	**16.3**	**15.9**	**13.4**	**15.9**	**14.7**	**16.0**	**9.9**	**17.8**	**20.5**	**16.5**	**15.6**
		11.4	12.1	11.2	11.0	11.7	11.9	12.2	10.9	9.6	10.3	10.2	11.1
	NW	**7.5**	**8.8**	**12.3**	**8.8**	**12.3**	**11.6**	**10.5**	**1.5**	**9.6**	**9.0**	**7.8**	**5.5**
		8.3	10.1	10.3	11.9	11.5	11.2	10.2	8.9	10.8	9.5	11.1	8.7
	calm	**10.3**	**8.1**	**4.7**	**4.9**	**4.7**	**4.4**	**6.1**	**7.7**	**8.9**	**10.2**	**9.7**	**10.4**

HOUR	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
18		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**2.4**	**3.5**	**3.3**	**3.7**	**3.3**	**4.2**	**3.3**	**3.6**	**4.3**	**3.1**	**2.6**	**2.5**
speed		6.8	7.4	8.4	7.6	6.4	6.8	7.1	8.2	7.0	8.0	7.7	6.6
	NE	**9.9**	**11.2**	**11.3**	**8.4**	**11.3**	**3.9**	**3.1**	**3.5**	**6.4**	**7.4**	**10.9**	**9.6**
		8.6	9.8	9.0	8.5	8.3	7.5	6.5	6.7	6.6	7.2	7.2	8.3
	E	**35.0**	**37.0**	**31.2**	**30.7**	**31.2**	**11.5**	**9.7**	**18.7**	**23.0**	**27.7**	**33.1**	**39.0**
		10.5	10.5	9.7	9.3	7.6	6.6	6.3	6.9	7.4	7.3	9.0	10.3
	SE	**6.5**	**6.5**	**7.5**	**6.7**	**7.5**	**6.3**	**5.0**	**4.3**	**4.7**	**4.3**	**4.6**	**6.1**
		7.9	8.7	8.1	7.4	6.8	5.6	5.8	6.3	6.3	6.0	7.8	9.6
	S	**7.0**	**7.3**	**7.8**	**13.6**	**7.8**	**20.7**	**22.8**	**17.6**	**12.6**	**11.0**	**8.7**	**9.3**
		8.4	9.0	8.1	7.1	7.6	7.8	6.5	7.0	7.3	7.4	7.9	8.6
	SW	**4.8**	**3.7**	**4.0**	**2.7**	**4.0**	**6.0**	**5.3**	**4.1**	**4.1**	**4.8**	**4.2**	**2.4**
		11.5	9.9	8.9	7.9	8.3	7.2	7.5	7.0	6.8	8.4	9.1	9.6
	W	**17.6**	**14.4**	**12.9**	**10.5**	**12.9**	**11.1**	**12.1**	**6.9**	**13.7**	**16.3**	**16.2**	**15.3**
		11.1	11.7	10.4	11.1	8.3	8.1	7.5	8.7	8.5	10.0	10.6	11.1
	NW	**7.2**	**7.9**	**9.8**	**8.7**	**9.8**	**12.9**	**11.4**	**12.6**	**8.1**	**8.0**	**7.0**	**4.7**
		9.6	10.1	10.8	10.8	7.9	8.2	8.5	8.1	8.4	8.6	10.8	9.9
	calm	**9.7**	**8.5**	**12.2**	**14.9**	**12.2**	**23.4**	**27.2**	**28.7**	**23.0**	**17.4**	**12.7**	**10.9**

HOUR (GMT)	WIND DIR.	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21		PERCENTAGE (%) OCCURRENCE [BOLD TYPE] WIND SPEED (KTS)											
	N	**2.6**	**3.5**	**3.9**	**3.4**	**3.9**	**4.9**	**4.1**	**4.0**	**2.4**	**2.9**	**2.6**	**1.2**
speed		7.9	7.1	8.0	8.3	8.4	8.0	7.5	7.3	8.5	7.6	8.5	6.9
	NE	**11.2**	**14.4**	**12.4**	**11.9**	**12.4**	**5.4**	**4.8**	**9.2**	**8.3**	**9.3**	**11.2**	**10.2**
		8.1	8.6	9.1	8.7	8.6	8.1	6.6	7.4	6.7	7.8	7.0	7.2
	E	**34.0**	**33.4**	**30.5**	**30.3**	**30.5**	**10.8**	**7.7**	**13.2**	**21.5**	**24.1**	**29.8**	**36.3**
		9.7	10.5	9.9	9.4	8.5	6.0	6.6	7.7	7.5	7.5	9.2	10.0
	SE	**4.5**	**3.5**	**4.7**	**3.9**	**4.7**	**2.1**	**2.2**	**2.9**	**3.7**	**2.9**	**4.0**	**5.6**
		8.4	9.5	8.3	6.6	6.7	5.3	4.4	6.3	6.0	6.7	8.1	9.3
	S	**5.8**	**8.0**	**8.0**	**7.3**	**8.0**	**12.3**	**9.6**	**8.5**	**10.7**	**9.3**	**9.4**	**8.9**
		8.9	8.8	7.4	7.5	6.5	6.5	6.4	7.5	6.7	8.1	7.6	8.6
	SW	**5.0**	**3.7**	**3.0**	**3.3**	**3.0**	**7.1**	**8.0**	**5.7**	**4.0**	**4.8**	**4.3**	**4.8**
		11.1	10.7	10.0	7.5	7.9	8.4	7.3	9.7	9.3	10.6	10.7	9.3
	W	**18.4**	**15.5**	**14.1**	**10.8**	**14.1**	**18.3**	**18.3**	**12.5**	**14.4**	**21.2**	**16.4**	**14.7**
		11.4	12.4	10.2	10.4	9.4	8.3	7.0	6.8	9.2	10.4	10.7	12.1
	NW	**7.1**	**6.7**	**8.5**	**10.2**	**8.5**	**12.4**	**11.6**	**10.8**	**8.9**	**5.6**	**7.4**	**6.0**
		9.4	11.0	10.1	9.7	7.9	7.9	7.6	8.4	7.2	8.8	9.9	10.6
	calm	**11.4**	**11.3**	**14.8**	**18.9**	**14.8**	**26.6**	**33.9**	**33.2**	**26.1**	**20.0**	**14.9**	**12.3**

ASTRAKHAN, RS
VISIBILITY CLIMATOLOGY
BY MONTH AND PENTAD
PERIOD OF RECORD: 1959-1986

PENTAD	CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	visibility in n m	PERCENTAGE (%) OCCURRENCE											
	V<.5	7.6	4.5	3.5	2.3	0.9	0.4	0.6	0.3	1.0	1.8	4.4	7.0
	.5≤V<1.5	4.5	5.9	4.8	2.3	0.4	0.4	***	0.1	0.2	0.3	4.0	3.7
	1.5≤V<3	15.7	17.3	16.0	9.6	3.5	0.8	0.3	0.9	1.7	6.1	10.9	17.0
	V≥3	72.2	72.3	75.7	85.8	95.2	98.4	99.0	98.7	97.1	91.8	80.7	72.3
2													
	V<.5	4.1	4.7	2.0	1.1	1.0	0.2	0.1	0.3	1.9	2.3	2.9	9.8
	.5≤V<1.5	6.0	3.1	3.0	1.6	0.8	0.1	***	0.2	0.3	0.8	2.3	5.2
	1.5≤V<3	18.0	14.1	13.3	8.4	2.5	0.8	1.0	1.1	3.1	5.8	10.0	16.8
	V≥3	71.9	78.1	81.7	88.9	95.7	98.9	98.9	98.3	96.6	91.0	84.8	68.2
3													
	V<.5	4.7	8.1	3.7	1.0	0.9	0.4	0.4	0.6	1.0	2.1	4.2	6.0
	.5≤V<1.5	3.8	6.5	4.2	1.9	0.9	0.4	0.3	***	1.0	1.1	2.1	6.0
	1.5≤V<3	21.0	19.6	14.6	6.7	2.4	1.7	0.4	2.0	3.7	4.8	13.3	17.5
	V≥3	70.5	65.8	77.5	90.4	95.9	97.5	98.9	97.4	94.3	92.0	80.4	70.5

PENTAD	CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
4	visibility in n m	PERCENTAGE (%) OCCURRENCE											
	V<.5	4.3	6.1	3.0	0.9	0.5	0.6	0.5	0.7	2.0	5.4	3.5	8.0
	.5≤V<1.5	5.8	6.4	3.8	0.8	0.3	0.1	***	0.2	1.0	1.7	3.6	6.8
	1.5≤V<3	22.0	21.0	13.9	4.5	1.6	1.0	0.7	0.8	2.9	7.4	14.2	19.9
	V≥3	67.9	66.5	79.3	93.8	97.6	98.3	98.8	98.3	94.1	85.4	78.7	65.3
5													
	V<.5	3.3	2.2	2.0	1.3	0.8	0.3	0.6	0.4	1.9	3.5	6.2	6.8
	.5≤V<1.5	5.2	4.8	3.0	1.0	***	***	0.1	0.4	1.0	1.8	5.6	5.9
	1.5≤V<3	20.2	14.2	14.8	7.3	1.9	1.5	1.0	1.8	4.8	9.0	18.0	16.5
	V≥3	71.3	78.8	80.2	90.4	97.3	98.2	98.3	97.4	92.3	85.7	70.2	70.8
6													
	V<.5	5.4	3.6	2.5	1.2	0.5	1.0	0.7	1.0	2.1	2.6	5.1	8.6
	.5≤V<1.5	5.8	3.3	3.9	0.6	0.3	0.4	0.2	0.4	0.7	1.4	4.2	6.7
	1.5≤V<3	18.5	11.3	12.0	5.2	1.0	1.3	1.1	2.1	6.4	9.8	18.4	21.9
	V≥3	70.3	81.8	81.6	93.0	98.2	97.3	98.0	96.5	90.8	86.2	72.3	62.8

*** Frequency of occurrence less than 0.1%.

Calculations based on a range of 931-1218 observations per cell with the exception of February which was based on a range of 645-1019 observations per cell.
Standard Deviation of data: 0.1% per cell.

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ASTRAKHAN, RS
PERCENTAGE OCCURRENCE OF VISIBILITY CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

HOUR (GMT)	CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 0	visibility in n m	PERCENTAGE (%) OCCURRENCE											
	V<.5	6.8	7.7	5.1	1.9	0.5	0.9	0.4	0.4	3.5	5.9	7.0	9.6
	.5≤V<1.5	3.1	4.2	2.6	1.3	0.2	0.8	0.1	0.4	0.8	1.4	3.0	4.5
	1.5≤V<3	15.9	13.4	15.9	7.6	3.1	1.5	1.3	2.6	6.7	8.6	14.2	15.7
	V≥3	74.2	74.7	76.4	89.2	96.2	96.8	98.2	96.6	89.0	84.1	75.8	70.2
0 3													
	V<.5	7.0	7.1	7.3	3.6	1.7	0.4	1.0	1.3	5.8	7.9	8.8	9.7
	.5≤V<1.5	4.2	4.1	5.7	4.5	1.6	0.3	0.3	0.6	2.4	2.5	3.3	3.6
	1.5≤V<3	15.2	17.0	22.3	16.3	5.8	4.5	2.8	5.6	10.5	12.4	14.6	15.8
	V≥3	73.6	71.8	64.7	75.6	90.9	94.8	95.9	92.5	81.3	77.2	73.3	70.9
0 6													
	V<.5	6.2	7.6	3.4	1.2	0.5	0.3	0.4	0.3	0.5	2.4	7.2	10.0
	.5≤V<1.5	10.9	10.1	8.2	1.5	0.2	0.3	0.0	0.1	1.4	2.9	8.9	10.7
	1.5≤V<3	28.4	25.0	23.1	8.4	1.7	1.4	0.3	1.2	3.7	11.5	19.8	25.1
	V≥3	54.5	57.3	65.3	88.9	97.6	98.0	99.3	98.4	94.4	83.2	64.1	54.2
0 9													
	V<.5	2.7	1.8	0.8	0.9	0.7	0.4	0.4	0.3	0.6	0.4	0.9	4.6
	.5≤V<1.5	7.5	8.6	3.3	0.6	0.3	0.1	0.1	0.2	0.2	0.9	4.8	7.9
	1.5≤V<3	22.5	17.5	11.5	4.6	1.2	0.6	0.6	1.1	0.6	6.1	15.4	22.2
	V≥3	67.3	72.1	84.4	93.9	97.8	98.9	98.9	98.3	98.6	92.6	78.9	65.3

HOUR (GMT)	CATEGORY	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1 2	visibility in n m	PERCENTAGE (%) OCCURRENCE											
	V<.5	2.5	1.5	0.5	0.8	0.9	0.3	0.5	0.5	0.1	0.6	0.9	3.5
	.5≤V<1.5	5.0	3.7	2.4	0.8	0.6	0.1	0.0	0.3	0.4	0.5	3.0	6.5
	1.5≤V<3	18.3	15.6	7.1	4.9	1.1	0.3	0.4	0.3	0.6	3.2	10.3	18.6
	V≥3	74.2	79.2	90.0	93.5	97.4	99.3	99.1	98.9	98.9	95.7	85.8	71.4
1 5													
	V<.5	3.0	2.9	0.4	0.3	0.3	0.7	0.1	0.4	0.6	0.6	2.2	6.4
	.5≤V<1.5	4.3	3.7	3.1	1.1	0.5	0.1	0.1	0.0	0.3	0.4	2.3	5.1
	1.5≤V<3	20.6	17.7	8.4	4.4	1.2	0.4	0.0	0.3	1.3	5.0	13.8	18.4
	V≥3	72.1	75.7	87.7	94.2	98.0	98.8	99.8	99.3	97.8	94.0	81.7	70.1
1 8													
	V<.5	5.3	4.6	1.2	0.5	0.5	0.5	0.7	0.4	0.0	1.3	3.2	7.6
	.5≤V<1.5	3.2	3.0	2.2	0.4	0.0	0.1	0.1	0.1	0.1	0.4	2.0	3.7
	1.5≤V<3	16.9	13.1	10.8	4.9	0.9	0.5	0.5	0.3	2.0	5.2	12.8	14.7
	V≥3	74.6	79.3	85.8	94.2	98.6	98.9	98.7	99.2	97.9	93.1	82.0	74.0
2 1													
	V<.5	5.4	6.2	3.3	1.4	1.1	0.4	0.5	0.8	2.3	4.5	4.8	10.2
	.5≤V<1.5	3.7	3.5	2.9	0.8	0.1	0.0	0.0	0.1	0.3	0.7	2.0	4.1
	1.5≤V<3	16.1	13.4	12.6	4.4	1.7	0.3	0.4	1.4	5.0	6.2	12.5	16.6
	V≥3	74.8	76.9	81.2	934	97.1	99.3	99.1	97.7	92.4	88.6	80.7	69.1

LST=GMT+4

Calculations based on a range of 667-805 observations per cell.
Standard Deviation of data: 0.1% per cell.
The greatest variability occurred during the winter months. Throughout the entire year, 7-10am were the hours of greatest variability in visibility.

ASTRAKHAN, RS
CEILING HEIGHT AND CLOUD COVER CLIMATOLOGY
BY MONTH
PERIOD OF RECORD: 1959-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	42.6	50.8	52.8	64.9	73.4	74.5	76.3	75.8	72.9	59.6	39.4	32.5
MIDDLE	12.8	12.9	16.1	21.8	20.1	20.0	19.6	19.9	19.3	16.9	14.3	11.5
LOW	44.6	36.3	31.1	13.3	6.5	5.5	4.1	4.3	7.8	23.5	46.3	56.0
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	36.0	40.6	41.6	47.6	54.6	60.5	68.8	69.3	65.6	51.7	33.8	26.6
MCLDY	19.7	20.5	25.5	32.5	33.8	32.0	25.3	24.4	24.3	26.9	24.9	21.5
OVC	38.9	33.5	30.5	19.5	11.5	7.5	5.9	6.3	9.5	20.0	37.6	42.9
OBSC	5.4	5.4	2.4	0.4	0.1	***	***	***	0.6	1.4	3.7	9.0

***Indicates percent occurrence less than 0.1%.

Calculations for CEILING HEIGHT based on a range of 242-4347 observations per cell. SKY COVER calculations based on a range of 1-3954 observations per cell.
Standard Deviation of data: 0.1% per cell. The greatest variability in CEILING HEIGHT occurred in winter months.

ASTRAKHAN, RS
CEILING HEIGHT AND SKY COVER CLIMATOLOGY
BY MONTH AND PENTAD
PERIOD OF RECORD: 1959-1986

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	41.2	52.3	47.8	61.5	68.3	78.7	74.9	72.6	76.5	65.3	49.1	35.0
MIDDLE	9.4	9.7	15.7	22.4	22.5	15.9	20.6	22.2	19.9	19.6	17.9	10.6
LOW	49.4	38.0	36.5	16.1	9.2	5.4	4.5	5.2	3.6	15.1	33.0	54.4
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	36.5	42.4	39.1	45.0	49.5	60.9	64.1	66.3	69.1	54.7	43.7	28.2
MCLDY	18.6	16.3	18.3	31.3	34.9	32.1	29.7	26.2	24.8	27.6	21.7	24.3
OVC	35.7	36.0	40.0	22.6	15.4	6.9	6.1	7.5	6.0	16.9	32.0	41.0
OBSC	9.2	5.3	2.6	1.1	0.2	0.1	0.1	0.0	0.1	0.8	2.6	6.5

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2	PERCENTAGE (%) OCCURRENCE.											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	42.7	52.2	58.0	61.5	80.4	74.2	77.2	75.9	73.5	62.3	49.8	33.6
MIDDLE	12.3	14.8	8.6	21.2	12.9	20.5	18.4	19.4	21.0	20.3	14.2	10.7
LOW	45.0	33.0	33.4	16.8	6.7	5.3	4.4	4.7	5.5	17.4	36.0	55.7
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	38.5	43.2	47.3	45.0	56.9	60.8	70.8	68.6	67.2	55.5	44.5	26.6
MCLDY	18.7	21.6	21.7	31.3	33.9	33.9	23.4	25.0	24.1	26.3	23.2	19.5
OVC	38.5	30.6	28.7	22.6	8.9	5.2	5.8	6.4	8.1	17.1	30.0	42.3
OBSC	4.3	4.6	2.3	1.1	0.3	0.0	0.0	0.0	0.6	1.1	2.3	11.6

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
3	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	42.3	44.4	48.5	68.9	78.4	75.7	73.3	78.4	76.5	68.8	39.5	31.8
MIDDLE	15.3	14.7	16.0	21.3	15.6	19.8	23.0	18.2	17.1	14.9	15.7	9.5
LOW	42.4	40.9	35.5	9.8	6.0	4.5	3.7	3.4	6.4	16.3	44.8	58.7
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	36.6	35.0	38.3	49.9	54.7	58.0	66.7	71.2	70.2	60.9	34.4	26.1
MCLDY	20.0	17.9	28.6	31.1	34.8	34.5	26.9	23.0	21.2	25.0	27.6	22.6
OVC	38.2	37.3	29.4	18.9	10.5	7.5	6.3	5.6	8.5	13.3	35.0	44.5
OBSC	5.2	9.8	3.7	0.1	0.0	0.0	0.1	0.2	0.1	0.8	3.0	6.8

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
4	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	36.5	49.1	54.1	62.8	73.8	68.9	77.3	73.2	75.2	58.8	35.1	24.1
MIDDLE	15.0	10.4	16.9	24.5	20.2	24.2	18.9	23.1	17.2	17.7	12.5	12.6
LOW	48.5	40.5	29.0	12.7	6.0	6.9	3.8	3.7	7.6	23.5	52.4	63.3
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	28.8	38.8	42.3	46.4	58.1	55.4	68.5	68.3	67.5	51.2	29.4	20.0
MCLDY	26.1	19.6	25.1	37.0	33.1	34.0	26.7	24.8	24.6	27.0	25.9	21.4
OVC	40.8	35.1	30.4	16.4	8.8	10.6	4.8	6.9	7.1	19.8	41.2	48.6
OBSC	4.3	6.5	2.2	0.2	0.0	0.0	0.0	0.0	0.8	2.0	3.5	10.0

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
5	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	44.0	49.8	50.5	67.6	70.4	71.4	80.3	75.9	69.4	56.9	30.7	43.3
MIDDLE	13.4	15.7	20.5	22.0	24.4	21.4	17.0	19.8	20.5	13.5	13.3	11.0
LOW	42.6	34.5	29.0	10.4	5.2	7.2	2.7	4.3	10.1	29.6	56.0	45.7
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	35.6	40.5	37.3	49.1	52.5	60.0	75.1	70.4	60.7	48.8	25.5	35.1
MCLDY	18.5	22.8	30.1	34.2	34.4	31.2	18.7	23.0	28.6	25.1	24.4	20.8
OVC	42.1	34.5	30.6	16.4	13.0	8.8	6.2	6.5	9.8	24.0	44.5	35.9
OBSC	3.8	2.2	2.0	0.3	0.1	0.0	0.0	0.1	0.9	2.1	5.6	8.2

PENTAD	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
6	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	47.2	59.9	56.5	66.6	69.5	78.2	75.4	78.5	66.2	47.3	30.8	27.4
MIDDLE	11.6	10.9	18.5	19.3	24.4	18.1	19.4	17.5	20.3	15.9	11.6	14.3
LOW	41.2	29.2	25.0	14.1	6.1	3.7	5.2	4.0	13.5	36.8	57.6	58.3
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	39.3	44.4	44.8	47.9	55.5	67.9	67.8	70.7	58.7	40.7	23.9	23.1
MCLDY	17.2	26.6	28.6	32.8	31.8	26.5	25.7	24.3	22.7	30.1	26.9	20.4
OVC	37.8	25.2	25.0	19.3	12.6	5.6	6.4	5.0	17.7	27.6	44.0	45.4
OBSC	5.7	3.8	1.6	0.0	0.1	0.0	0.1	0.0	0.9	1.6	5.2	11.1

ASTRAKHAN, RS
CEILING HEIGHT AND SKY COVER CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
00	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	41	50	53	67	74	78	79	80	76	60	40	31
MIDDLE	12	11	13	20	21	20	19	18	15	17	13	9
LOW	47	39	34	13	6	2	2	2	9	23	47	59
SKY COVER	PCLDY ≤ 4/8				MCLDY: 5/8-7/8			OVC = 8/8		OBSC = 9/8		
PCLDY	37	44	48	58	64	69	75	77	73	57	36	28
MCLDY	13	15	14	21	21	23	18	15	14	17	20	15
OVC	42	22	34	20	14	8	7	8	11	23	39	46
OBSC	7	9	5	1	***	***	***	***	2	3	5	11

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 3	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	41	46	46	61	69	74	74	72	70	55	39	30
MIDDLE	11	13	16	26	26	23	24	25	22	18	13	11
LOW	48	40	38	13	5	3	2	2	8	27	48	59
SKY COVER	PCLDY $\leq$ 4/8				MCLDY: 5/8-7/8			OVC = 8/8		OBSC = 9/8		
PCLDY	36	40	38	44	51	61	66	65	63	49	36	28
MCLDY	15	15	19	37	36	31	27	29	25	24	17	15
OVC	42	37	35	18	12	8	7	5	10	23	40	46
OBSC	7	8	8	1	***	0	0	***	2	4	7	11

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
06	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	37	45	48	64	72	74	74	76	71	58	36	29
MIDDLE	14	17	19	24	21	22	23	21	23	18	14	15
LOW	49	39	32	13	7	4	3	3	6	24	50	56
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	30	31	37	44	51	57	65	65	63	47	27	20
MCLDY	22	26	29	36	37	33	27	28	28	32	29	27
OVC	39	34	30	19	12	10	8	7	9	19	36	40
OBSC	9	9	4	1	***	0	***	0	0	2	8	13

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 9	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	48	51	50	63	73	72	74	72	70	56	38	34
MIDDLE	14	14	15	20	18	18	19	21	19	16	18	14
LOW	38	35	35	17	9	10	7	9	11	28	44	52
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	36	35	34	41	49	55	65	63	61	44	29	26
MCLDY	28	30	37	41	40	39	28	30	30	40	35	28
OVC	33	33	28	18	11	6	7	7	9	16	35	40
OBSC	3	2	***	0	0	0	0	0	0	***	1	6

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
12	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	44	54	53	62	71	69	72	72	67	60	42	37
MIDDLE	15	14	17	20	17	18	17	18	21	16	15	14
LOW	41	32	30	18	12	13	11	10	12	24	43	49
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	33	38	37	38	46	51	63	63	59	49	31	26
MCLDY	29	29	38	43	43	42	31	31	32	35	36	30
OVC	36	32	26	19	11	7	6	6	9	16	33	40
OBSC	2	1	***	0	***	0	0	0	0	0	***	4

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
15	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	44	53	57	65	73	73	75	75	75	64	39	34
MIDDLE	13	14	19	23	23	21	21	21	19	16	15	10
LOW	43	34	24	11	4	6	4	4	6	20	46	56
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	38	40	39	40	47	55	66	68	62	53	35	27
MCLDY	22	23	34	40	42	39	30	26	30	27	21	23
OVC	36	34	27	19	11	6	4	6	8	20	42	44
OBSC	4	3	0	***	0	0	0	0	0	0	2	6

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
18	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG ≥ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG ≤ 1800 m			
HIGH	43	54	58	68	77	76	79	79	77	62	40	33
MIDDLE	11	11	15	22	18	21	19	19	19	18	13	10
LOW	47	35	28	10	5	3	2	2	4	20	47	57
SKY COVER	PCLDY ≤ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	37	47	50	58	61	63	71	75	72	55	39	29
MCLDY	16	15	16	21	30	30	25	19	19	22	20	19
OVC	41	33	33	21	9	7	4	6	9	22	38	43
OBSC	6	5	1	***	0	0	***	0	0	1	3	9

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21	PERCENTAGE (%) OCCURRENCE											
CEILING HEIGHT	HIGH CIG $\geq$ 6000 m				MIDDLE CIG: 2100-5700 m				LOW CIG $\leq$ 1800 m			
HIGH	43	53	55	69	78	80	84	81	77	60	41	32
MIDDLE	13	11	15	20	17	17	15	18	17	17	13	10
LOW	4	36	30	11	5	3	1	1	6	23	46	58
SKY COVER	PCLDY $\leq$ 4/8			MCLDY: 5/8-7/8			OVC = 8/8			OBSC = 9/8		
PCLDY	41	45	48	59	67	74	79	78	73	56	37	28
MCLDY	14	14	15	21	21	18	16	16	16	20	21	17
OVC	40	34	34	20	12	8	5	6	11	21	38	44
OBSC	5	7	3	0	0	0	0	0	***	3	4	11

***Indicates at least one observation in the particular category.

Calculations for CEILING HEIGHT based on a range of 65-567 observations per cell.
SKY COVER calculations based on a range of 1-567 observations per cell.
Standard Deviation of data: 0.1% per cell. The greatest variability in CEILING HEIGHT occurred in winter months.

ASTRAKHAN, RS
WEATHER CLIMATOLOGY
BY MONTH
PERIOD OF RECORD: 1959-1986

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	0.9	1.1	0.4	0.8	0.3	0.1	0.0	0.1	0.2	0.1	***	***
HAZE & SMOKE	0.3	0.6	1.4	2.3	0.5	0.1	0.3	0.2	0.5	0.4	0.3	0.2
FOG	5.1	4.8	2.7	0.5	0.2	0.1	***	0.2	1.3	2.7	4.4	8.1
DRIZZLE	2.6	1.7	0.9	0.3	0.1	***	***	0.0	0.0	0.1	2.0	4.3
RAIN	1.3	1.1	2.5	4.0	2.6	1.5	0.8	0.8	2.1	3.3	4.3	1.8
SHOWERS	0.2	0.3	0.4	0.5	1.0	1.1	1.1	1.0	0.6	0.4	0.3	0.5
THUNDERSTORMS	0.0	0.0	***	***	0.2	0.2	0.2	0.2	0.2	0.0	0.0	***
SNOW	8.1	8.6	4.4	0.4	0.0	***	***	***	***	0.5	2.1	7.2
NONE	81.4	81.8	87.4	91.2	95.0	96.8	97.5	97.5	95.1	92.5	86.6	77.9

***Indicates frequency of occurrence less than 0.1%.

Calculations for specific weather types ranged from 1-5603 observations per cell.
Standard Deviation of data: 0.1% per cell.

ASTRAKHAN, RS
WEATHER CLIMATOLOGY
BY MONTH AND HOUR
PERIOD OF RECORD: 1959-1986

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
00	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	0	***	0	0	0	***	0	***	0	***
HAZE & SMOKE	***	***	1	1	***	0	***	***	1	***	***	0
FOG	7	9	6	1	1	1	***	***	4	6	8	10
DRIZZLE	4	1	1	***	***	***	0	0	0	***	2	5
RAIN	1	1	3	4	4	1	***	1	2	4	4	2
SHOWERS	***	***	0	***	***	1	1	1	1	***	0	***
THUNDERSTORMS	0	0	0	0	***	0	***	***	***	0	0	***
SNOW	7	7	4	***	0	0	0	0	0	1	2	7
NONE	80	80	84	93	94	97	98	97	93	89	85	76

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 3	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	***	1	***	***	0	0	0	***	0	0
HAZE & SMOKE	***	***	***	2	***	0	***	***	***	0	***	0
FOG	7	7	9	4	1	***	0	1	6	9	9	10
DRIZZLE	3	2	2	0	0	***	***	0	0	0	3	5
RAIN	2	1	3	4	3	2	1	1	20	4	4	2
SHOWERS	***	***	0	***	1	2	1	1	1	***	***	***
THUNDERSTORMS	0	0	0	0	***	***	0	***	***	0	0	0
SNOW	7	9	6	***	0	0	0	0	0	***	2	8
NONE	80	79	79	89	94	95	97	97	91	86	82	76

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
0 6	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	***	1	***	0	0	***	0	***	0	0
HAZE & SMOKE	***	0	1	2	***	0	***	***	***	***	1	***
FOG	9	8	3	***	0	0	0	0	***	2	9	11
DRIZZLE	3	2	1	***	0	0	***	0	0	***	3	7
RAIN	2	0	2	5	3	3	2	1	4	4	5	2
SHOWERS	0	1	***	***	1	1	1	1	***	***	0	***
THUNDERSTORMS	0	0	***	0	0	0	0	***	0	0	0	0
SNOW	11	16	8	1	0	0	***	0	0	1	2	11
NONE	74	71	84	90	95	96	97	98	96	93	79	69

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
09	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	***	2	1	***	0	***	***	***	***	***
HAZE & SMOKE	1	1	2	3	1	***	***	***	***	1	***	0
FOG	3	2	***	0	***	0	0	0	0	***	1	6
DRIZZLE	2	2	***	***	***	0	0	0	0	***	2	3
RAIN	1	1	2	3	2	1	1	1	2	2	4	2
SHOWERS	0	***	1	***	1	1	2	1	1	1	1	***
THUNDERSTORMS	0	0	***	0	0	0	0	***	0	0	0	0
SNOW	10	10	4	***	0	0	0	0	0	***	3	9
NONE	83	83	90	91	95	97	97	97	97	96	90	79

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
12	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	1	2	1	***	0	***	1	***	0	***
HAZE & SMOKE	***	1	1	3	1	***	***	***	***	***	***	***
FOG	2	***	***	0	0	0	0	0	0	0	***	4
DRIZZLE	2	1	1	***	***	0	0	0	0	0	1	3
RAIN	2	1	2	4	2	1	1	1	2	3	4	2
SHOWERS	***	***	1	1	1	1	1	1	1	1	1	1
THUNDERSTORMS	0	0	0	0	***	1	1	***	***	0	0	0
SNOW	7	7	3	***	0	0	0	0	0	1	2	6
NONE	86	89	92	90	95	96	97	97	97	95	92	84

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
15	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	1	***	***	0	0	0	***	0	0	0
HAZE & SMOKE	1	1	2	4	1	***	***	***	1	1	1	***
FOG	2	2	0	0	0	***	0	0	0	***	1	6
DRIZZLE	2	2	1	***	***	0	0	0	0	0	2	2
RAIN	2	1	3	4	2	1	***	1	2	3	5	2
SHOWERS	0	***	***	1	1	1	1	1	***	1	***	2
THUNDERSTORMS	0	0	0	***	0	***	***	***	***	0	0	0
SNOW	7	8	3	***	0	***	0	0	0	1	2	5
NONE	85	86	90	90	95	97	98	97	97	95	89	82

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
18	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	1	1	***	***	0	0	0	0	***	***	0	0
HAZE & SMOKE	***	1	1	3	1	***	***	***	1	***	***	***
FOG	5	4	1	0	0	0	0	0	0	1	3	8
DRIZZLE	3	2	1	***	0	0	***	0	0	***	2	4
RAIN	1	1	3	4	2	1	1	***	2	4	5	2
SHOWERS	***	***	***	1	1	1	1	1	1	***	***	0
THUNDERSTORMS	0	0	0	0	***	1	***	***	0	0	0	0
SNOW	8	7	4	0	0	0	0	0	0	***	2	5
NONE	82	84	89	93	96	97	98	98	96	95	88	81

HOUR (GMT)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
21	PERCENTAGE (%) OCCURRENCE											
WEATHER												
DUST	***	1	***	0	0	0	0	0	0	***	0	0
HAZE & SMOKE	***	1	2	1	***	***	***	***	***	***	0	***
FOG	6	6	4	***	0	***	0	***	2	4	5	10
DRIZZLE	2	3	1	***	***	0	0	0	0	0	2	6
RAIN	1	1	3	4	3	2	***	***	2	4	4	2
SHOWERS	***	***	***	1	1	1	1	***	***	***	0	***
THUNDERSTORMS	0	0	0	0	***	***	***	***	***	0	0	0
SNOW	9	7	4	***	0	0	0	***	***	***	2	7
NONE	81	82	87	93	95	97	98	99	95	91	87	75

***Indicates at least one occurrence of the specific weather event.

Calculations for specific weather types ranged from 1-702 observations per cell.
Standard Deviation of data: 0.1% per cell.

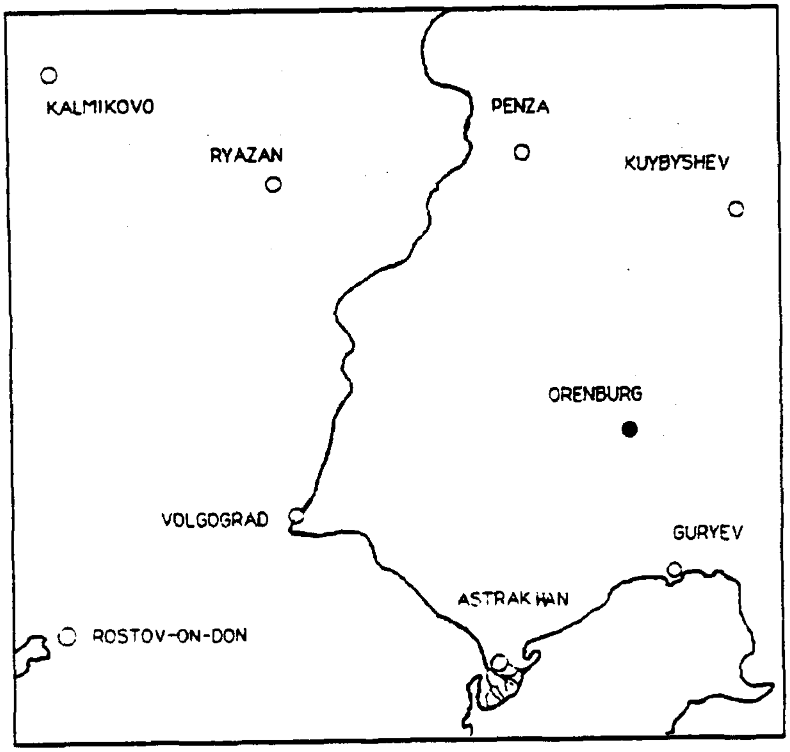
APPENDIX C

CLIMATOLGOICAL DATA FOR ORENBURG, RA

STATION: ORENBURG, RA

LOCATION: 51° 45' N 55° 07' E

ELEVATION: 109 m



ORENBURG, RA
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T	morning	max	289.5	275.8	280.2	290.8	296.2	305.2	313.0	300.1	303.0	295.0	299.2	302.0
(K)		mean	258.3	257.1	264.6	276.0	283.5	287.9	290.4	288.0	282.5	274.9	269.1	262.5
		min	238.2	234.1	240.8	255.8	268.5	236.2	279.2	273.0	269.1	255.0	249.0	239.2
	afternoon	max	275.2	285.0	289.0	302.0	315.0	309.7	316.0	313.0	308.2	300.0	287.2	278.2
		mean	261.1	261.9	270.0	284.0	293.4	297.0	299.5	297.8	291.6	280.2	271.4	264.6
		min	238.2	244.0	248.9	266.9	276.9	277.4	285.2	282.2	273.2	263.0	249.4	239.2
T_d	morning	max	275.0	274.2	277.0	284.1	289.1	298.2	294.2	292.2	288.2	284.4	280.8	276.2
(K)		mean	255.6	254.4	262.5	272.3	276.8	282.5	285.3	282.5	277.5	272.0	267.0	259.8
		min	232.2	228.2	226.0	239.2	239.0	236.2	253.0	241.2	253.0	228.0	225.0	236.9
	afternoon	max	274.2	274.2	285.2	286.2	298.2	294.2	294.2	296.2	295.0	287.9	280.2	276.2
		mean	257.6	257.8	265.6	272.6	276.0	281.7	284.0	281.7	277.5	272.7	268.0	261.3
		min	233.2	242.0	244.1	254.2	249.1	254.0	260.2	246.0	248.2	238.2	238.0	235.2
RH	morning	mean	81	82	86	79	65	74	75	73	74	82	86	82
(%)	afternoon	mean	77	73	73	49	33	38	38	39	43	62	80	79
SLP	morning	max	1059.7	1079.6	1056.6	1047.5	1040.2	1049.7	1047.7	1029.0	1039.4	1048.0	1057.4	1058.7
(mb)		mean	1025.2	1026.4	1025.4	1019.5	1017.4	1011.4	1009.9	1013.7	1017.4	1020.1	1023.5	1025.7
		min	983.9	978.2	987.0	984.3	982.1	979.7	971.1	983.1	985.5	925.1	985.7	984.3
	afternoon	max	1061.3	1087.6	1055.5	1047.0	1039.3	1027.9	1021.5	1063.7	1037.3	1057.6	1055.3	1058.9
		mean	1024.9	1026.3	1025.6	1018.9	1016.5	1010.6	1009.3	1012.9	1016.6	1020.0	1023.7	1025.3
		min	978.7	984.5	985.3	989.1	996.5	976.3	994.2	969.4	977.4	973.6	985.6	983.3
R	monthly	max	61.0	55.9	53.3	104.1	127.0	124.5	124.5	137.2	91.4	78.7	73.7	71.1
(mm)		mean	35.6	22.9	20.3	22.9	38.1	43.2	38.1	33.0	25.4	33.0	43.2	38.1
		min	2.5	T	T	0.0	7.6	12.7	12.7	0.0	2.5	T	5.1	2.5
	24-hour	max	15.2	15.2	20.3	33.0	30.5	35.6	35.6	27.9	17.8	22.9	20.3	30.5

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	E,S/E,S, SW	E,S/E,S, SW	E,S/E,S, SW	E,W/E,W	E,W/W, NW	E,W/W, E	E,W/W, NW	E,W/W, NW	E,W/W,S	W,E,S/ W,S,SW	E,W/E,W	E,S/E,S
WND SP (kt)	am/pm	10/10	11/11	11/11	9/12	9/12	8/12	8/12	8/12	8/12	9/12	10/10	9/10
VIS (%)	am/pm												
[nm] < 0.5		4/2	3/1	9/2	4/1	1/*	1/*	1/*	1/*	1/*	3/1	5/4	3/3
0.5-1.5		4/10	8/10	8/6	3/2	*/*	1/*	1/*	1/*	2/*	2/3	6/10	5/8
1.5-3		18/27	20/26	23/23	13/6	4/1	7/1	7/1	6/1	8/2	12/8	16/19	14/25
>3		74/61	69/63	60/69	80/91	95/98	91/98	91/98	92/98	89/97	82/88	73/67	78/64
SKY (%)	am/pm												
PCLDY		34/29	38/34	34/34	49/32	52/36	46/29	52/33	58/40	49/29	33/22	26/19	32/28
MCLDY		16/30	18/31	19/33	29/47	36/52	42/62	39/62	34/53	35/54	27/47	20/36	17/29
OVC		47/40	42/35	39/31	19/20	11/12	11/9	8/5	8/7	15/17	37/31	49/42	48/42
OBSC		3/ 1	2/1	9/1	3/*	*/0	*/*	*/0	*/0	*/0	2/*	5/4	3/1
CIG (%)	am/pm												
HIGH		42/47	47/57	43/55	63/57	69/57	60/45	64/45	67/53	59/47	40/34	32/32	38/42
MIDDLE		18/23	17/23	17/20	18/15	18/13	22/17	21/17	21/17	21/20	19/21	15/17	17/18
LOW		40/30	36/20	40/25	19/29	13/30	18/38	15/38	12/30	19/33	41/45	53/50	45/40
WX (%)	am/pm												
DUST		6/8	8/9	2/3	*/*	*/*	*/*	0/*	*/*	0/*	*/*	2/1	5/4
HZ&SM		0/*	*/1	*/1	*/1	*/*	0/0	0/*	*/*	*/1	0/*	0/*	*/*
FOG		2/*	2/*	10/1	4/*	*/0	1/0	*/0	*/0	*/0	3/*	5/4	3/2
DRIZZLE		1/1	1/*	2/1	*/*	0/0	0/0	0/*	*/0	*/*	*/1	4/2	1/1
RAIN		*/*	*/1	2/2	5/3	3/2	2/2	1/1	1/2	5/4	7/6	4/3	1/1
SHOWERS		*/*	*/*	*/*	1/2	1/2	2/3	2/2	2/2	2/2	1/2	*/1	*/1
TSTMS		0/0	0/0	0/0	0/*	*/1	1/2	*/2	*/1	0/*	0/0	0/0	0/0
SNOW		31/26	28/20	18/10	2/1	0/0	*/*	0/*	0/0	*/0	6/5	18/18	26/25
NONE		59/64	60/68	66/82	87/92	96/94	94/93	96/95	95/95	92/92	83/86	68/71	64/65

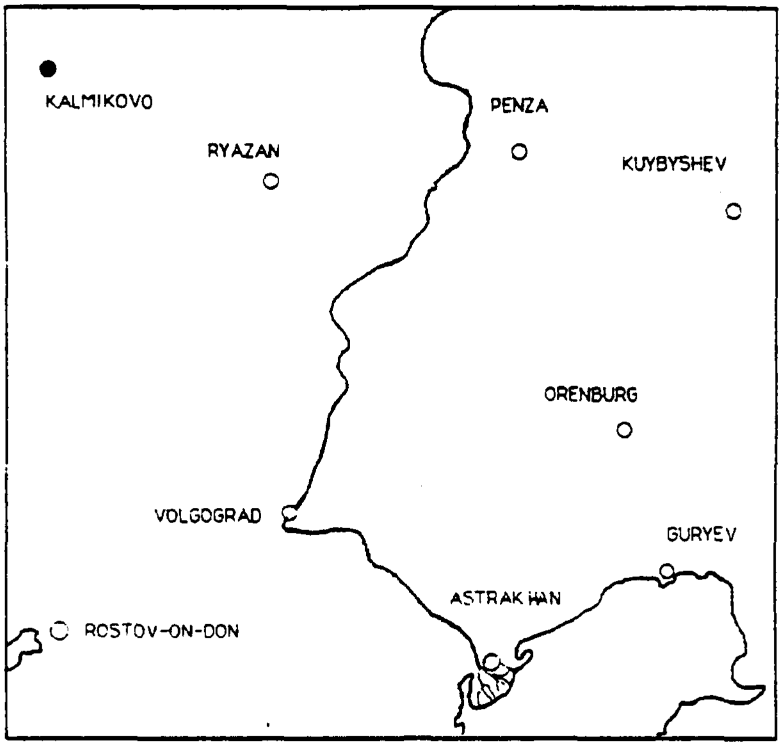
APPENDIX D

CLIMATOLOGICAL DATA FOR KALMIKOVO, RA

STATION: KALMIKOVO, RA

LOCATION: 49° 03' N 51° 53' E

ELEVATION: 4 m



KALMIKOVO, RA
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	296.0	300.0	291.0	301.0	303.0	313.0	315.2	318.0	303.2	302.0	302.2	291.0
		mean	261.3	259.6	266.4	277.9	285.5	290.4	293.0	290.8	284.2	276.4	271.0	265.0
		min	235.8	235.8	235.2	253.2	267.2	264.7	273.0	253.2	268.5	254.0	246.9	240.2
	afternoon	max	289.0	285.0	300.2	307.8	309.1	316.9	316.0	315.0	320.0	309.3	301.2	306.0
		mean	264.2	264.2	272.5	287.4	295.7	300.3	302.6	300.8	294.1	283.4	275.0	267.5
		min	240.2	248.7	251.9	265.7	273.0	253.0	275.0	286.9	273.0	264.1	255.2	245.2
Td (K)	morning	max	277.0	275.2	278.2	287.1	292.0	293.0	293.2	293.1	293.2	285.2	295.2	277.2
		mean	258.7	257.0	264.3	273.7	277.7	281.9	283.9	282.0	277.7	272.7	268.7	262.4
		min	226.2	225.0	240.8	253.0	237.0	253.2	252.0	252.0	236.0	227.0	229.0	233.2
	afternoon	max	277.0	276.9	286.9	294.1	294.7	300.2	299.0	300.0	290.2	287.2	283.0	279.2
		mean	261.1	260.8	267.8	273.5	276.8	280.4	282.7	281.3	277.2	273.1	270.1	264.0
		min	235.0	240.2	241.2	243.0	239.0	253.0	234.0	260.1	251.0	240.0	225.0	226.0
RH (%)	morning	mean	83	82	87	77	59	55	56	58	67	78	85	82
	afternoon	mean	79	78	73	44	31	30	32	31	37	55	75	78
SLP (mb)	morning	max	1058.3	1050.7	1055.0	1052.4	1050.2	1036.1	1030.9	1046.2	1038.1	1043.5	1060.2	1055.6
		mean	1024.3	1024.4	1023.5	1018.0	1016.3	1011.1	1008.8	1013.0	1017.2	1020.5	1023.4	1024.1
		min	983.0	975.4	981.3	991.1	987.4	981.4	970.5	965.3	992.1	991.1	980.9	982.8
	afternoon	max	1066.4	1066.1	1053.6	1050.9	1046.6	1053.1	1028.7	1052.3	1037.8	1051.1	1048.8	1054.9
		mean	1024.0	1024.7	1023.4	1017.5	1016.2	1010.5	1008.7	1012.8	1016.9	1020.5	1023.4	1024.0
		min	951.4	982.0	989.4	906.7	987.4	970.2	969.1	981.8	974.0	939.1	990.0	979.7
R (mm)	monthly	max	***	***	***	***	***	***	***	***	***	***	***	***
		mean	20.3	15.2	25.4	25.4	17.8	40.6	25.4	25.4	12.7	27.9	22.9	15.2
		min	***	***	***	***	***	***	***	***	***	***	***	***
	24-hour	max	***	***	***	***	***	***	***	***	***	***	***	***

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	E,S/E,S	E,SE,S/ E,S	E,SE,S/ E,W	E,NE,SE /E,SE	E,W/E, W	W,NW/ W,NW	NW,W/ W,NW	E,W/W, NW	W,E/W, S	W,S/W,S	E,SE,W/ E-W,SE	E,SE/E, SE,S
WND SP (kt)	am/pm	10/10	9/10	8/10	9/11	8/11	9/12	8/12	7/11	9/12	12/13	8/9-11	10/10
VIS (%)	am/pm												
[nm] < 0.5		8/7	10/4	12/3	2/1	1/1	1/2	1/2	1/2	3/3	3/2	8/5	10/8
0.5-1.5		3/3	3/2	2/2	1/1	*/1	0/1	*/1	*/1	*/1	1/1	2/2	2/3
1.5-3		11/10	11/10	12/8	6/4	3/4	1/4	1/4	3/4	4/4	8/6	9/8	11/10
>3		78/80	76/83	73/87	91/94	95/94	98/93	98/93	95/93	93/92	88/91	81/85	76/79
SKY (%)	am/pm												
PCLDY		43/33	49/44	44/39	59/40	60/44	56/36	67/43	70/48	64/48	51/35	41/29	41/31
MCLDY		12/26	12/24	15/30	21/42	29/45	34/55	25/49	20/43	21/40	18/35	14/27	12/23
OVC		39/37	33/30	32/29	19/18	10/10	10/9	8/8	10/8	14/12	29/29	39/40	38/39
OBSC		6/4	7/2	9/2	1/*	*/0	0/*	0/*	0/0	1/0	2/1	6/4	8/7
CIG (%)	am/pm												
HIGH		49/47	55/57	49/53	68/56	73/59	67/49	75/51	76/57	70/60	56/47	47/39	47/43
MIDDLE		14/19	11/15	15/18	15/15	16/13	20/14	15/14	14/16	15/15	16/15	15/17	13/16
LOW		37/34	34/28	36/29	17/29	11/28	13/38	10/35	10/26	15/25	28/38	38/44	40/40
WX (%)	am/pm												
DUST		5/7	4/5	1/2	0/3	*/5	*/5	*/7	*/7	*/6	0/3	1/1	2/3
HZ&SM		0/0	*/0	*/*	*/1	*/1	*/1	*/1	*/1	*/1	0/*	*/*	*/*
FOG		6/3	8/1	11/2	1/*	*/0	0/0	0/0	*/0	1/*	2/*	8/5	9/6
DRIZZLE		2/1	1/1	1/1	*/*	0/0	*/*	0/0	0/*	*/*	1/1	2/1	2/1
RAIN		1/1	1/1	1/1	3/2	2/2	1/2	1/1	1/1	2/2	4/4	3/4	1/1
SHOWERS		0/*	0/0	1/*	*/1	1/1	1/2	1/1	1/1	1/1	1/1	*/*	*/*
TSTMS		0/0	0/0	0/0	0/*	*/*	*/1	*/1	*/1	0/*	0/0	0/0	0/0
SNOW		8/10	9/9	7/4	1/1	0/0	0/0	*/0	0/*	0/0	1/1	4/3	7/11
NONE		78/78	77/82	79/90	95/92	96/91	97/89	97/89	96/89	95/90	91/90	81/85	79/78

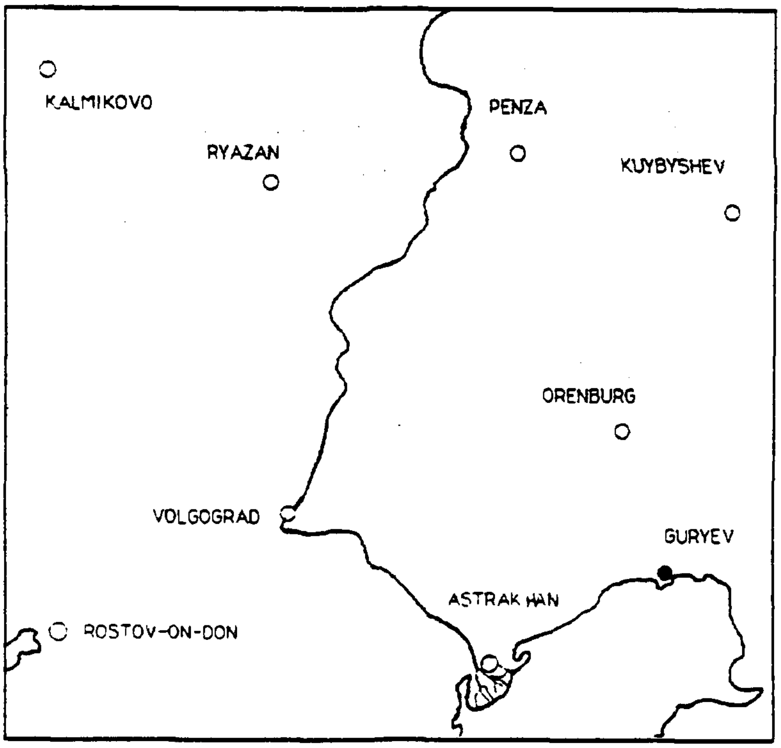
APPENDIX E

CLIMATOLOGICAL DATA FOR GURYEV, RA

STATION: GURYEV, RA

LOCATION: 47° 01' N 51° 52' E

ELEVATION: 23 m



GURYEV, RA
CLIMATOLOGICAL DATA.
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	277.0	284.0	284.1	291.4	299.2	304.2	304.1	311.0	301.9	293.0	293.2	279.2
		mean	263.9	262.7	269.7	279.8	287.1	291.6	293.9	292.0	285.5	278.0	272.5	267.3
		min	239.1	240.8	246.7	265.2	273.0	263.6	253.0	253.0	272.0	259.1	249.1	245.2
	afternoon	max	300.0	300.1	299.2	313.0	315.0	313.0	315.0	314.1	307.3	298.0	301.9	299.2
		mean	267.4	268.2	276.2	288.8	296.8	301.0	303.7	302.1	295.2	284.9	276.8	270.1
		min	246.0	249.1	255.5	271.9	273.2	274.0	288.0	276.0	276.2	267.0	258.1	249.1
Td (K)	morning	max	276.0	275.8	281.2	288.0	291.2	295.8	298.9	296.3	295.0	288.0	282.6	278.2
		mean	261.7	260.3	267.3	274.4	278.5	282.8	285.1	283.5	279.4	274.2	270.0	265.0
		min	234.0	235.0	245.2	232.0	244.0	238.0	245.0	250.0	242.0	252.0	229.0	239.1
	afternoon	max	278.0	278.2	287.2	300.2	291.9	300.2	296.9	295.2	296.2	288.8	284.2	279.2
		mean	263.9	263.6	268.8	273.2	276.2	280.5	283.3	282.0	278.5	274.3	271.3	266.6
		min	240.0	240.2	235.0	227.0	245.0	253.0	225.8	226.0	237.0	255.8	236.0	239.2
RH	morning	mean	85	83	84	71	57	59	57	58	66	77	85	87
(%)	afternoon	mean	77	70	58	38	27	28	28	28	35	52	69	79
SLP (mb)	morning	max	1055.1	1050.3	1049.2	1035.7	1041.8	1029.4	1025.3	1026.6	1036.9	1054.0	1058.5	1052.3
		mean	1023.8	1024.0	1022.6	1017.1	1015.7	1011.1	1009.6	1012.5	1017.4	1021.4	1023.5	1023.6
		min	990.1	992.6	982.7	990.8	986.9	980.0	985.6	983.7	980.5	978.0	986.2	983.5
	afternoon	max	1052.3	1054.8	1053.4	1036.0	1036.5	1045.3	1022.2	1026.3	1037.0	1046.5	1046.0	1056.5
		mean	1023.9	1023.8	1022.6	1017.0	1015.7	1010.8	1009.3	1012.4	1017.2	1021.6	1023.5	1023.8
		min	971.1	985.5	983.8	991.9	972.6	957.6	971.4	993.6	979.7	997.5	993.2	993.4
R (mm)	monthly	max	27.9	38.1	30.5	30.5	55.9	68.6	86.4	50.8	55.9	45.7	53.3	27.9
		mean	12.7	12.7	10.2	15.2	17.8	17.8	12.7	10.2	15.2	10.2	15.2	17.8
		min	2.5	5.1	0.0	0.0	0.0	2.5	0.0	0.0	0.0	T	0.0	T
	24-hour	max	17.8	12.7	17.8	30.5	27.9	33.0	86.4	45.7	48.3	22.9	22.9	17.8

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	E,SE/E,S	E,W/E,S	E,NE,W/ E,W	E,NE/E,S	E,W/E- S,W	W,E,NW /S,W	W,NW/ S-W-NW	E,NW/S, NW	E,W/S,W	E,W/W,S	E,W/E, SE,W	E,SE/E, SE
WND SP (kt)	am/pm	12/12	12/13	13/14	11/14	10/13	9/11	8/13	9/11	9/11	9/14	10/11	12/11
VIS (%)	am/pm												
[nm] < 0.5		8/4	6/3	6/3	2/3	1/2	1/1	1/2	*/1	1/1	3/1	6/3	8/6
0.5-1.5		6/9	6/8	6/7	2/5	*/1	*/1	*/1	*/1	1/1	2/3	4/5	7/11
1.5-3		17/20	19/19	18/14	8/7	3/4	2/4	2/4	2/3	4/5	9/7	15/14	18/20
>3		69/67	69/69	69/77	88/85	95/93	97/94	97/93	98/95	94/93	86/89	75/78	67/63
SKY (%)	am/pm												
PCLDY		43/33	49/44	44/39	59/40	60/44	56/36	67/43	70/48	64/48	51/35	41/29	41/31
MCLDY		12/26	12/24	15/30	21/42	29/45	34/55	25/49	20/43	21/40	18/35	14/27	12/23
OVC		39/37	33/30	32/29	19/18	10/10	10/9	8/8	10/8	14/12	29/29	39/40	38/39
OBSC		6/4	7/2	9/2	1/*	*/*	0/*	0/*	0/*	1/0	2/1	6/4	8/7
CIG (%)	am/pm												
HIGH		49/47	55/57	49/53	68/56	73/59	67/49	75/51	76/57	70/60	56/47	47/39	47/43
MIDDLE		14/19	11/15	15/18	15/15	16/13	20/14	15/14	14/16	15/15	16/15	15/17	13/16
LOW		37/34	34/28	36/29	17/29	11/28	13/38	10/35	10/26	15/25	28/38	38/44	40/40
WX (%)	am/pm												
DUST		5/7	4/5	1/2	0/3	*/5	*/5	*/7	*/7	*/6	0/3	1/1	2/3
HZ&SM		0/0	*/0	*/*	*/1	*/1	*/1	*/1	*/1	*/1	0/*	*/*	*/*
FOG		6/3	8/1	11/2	1/*	*/0	0/0	0/0	*/0	1/0	2/*	8/5	9/6
DRIZZLE		2/1	1/1	1/1	*/*	0/0	*/*	0/0	0/*	*/*	1/1	2/1	2/1
RAIN		1/1	1/1	1/1	3/2	2/2	1/2	1/1	1/1	2/2	4/4	3/4	1/1
SHOWERS		0/*	0/0	1/*	*/1	1/1	1/2	1/1	1/1	1/1	1/1	*/*	*/*
TSTMS		0/0	0/0	0/0	0/*	*/*	*/1	*/1	*/1	0/*	0/0	0/0	0/0
SNOW		8/10	9/9	7/4	1/1	0/0	0/0	*/0	0/*	0/0	1/1	4/3	7/11
NONE		78/78	77/82	79/90	95/92	96/91	97/89	97/89	96/89	95/90	91/90	81/85	79/78

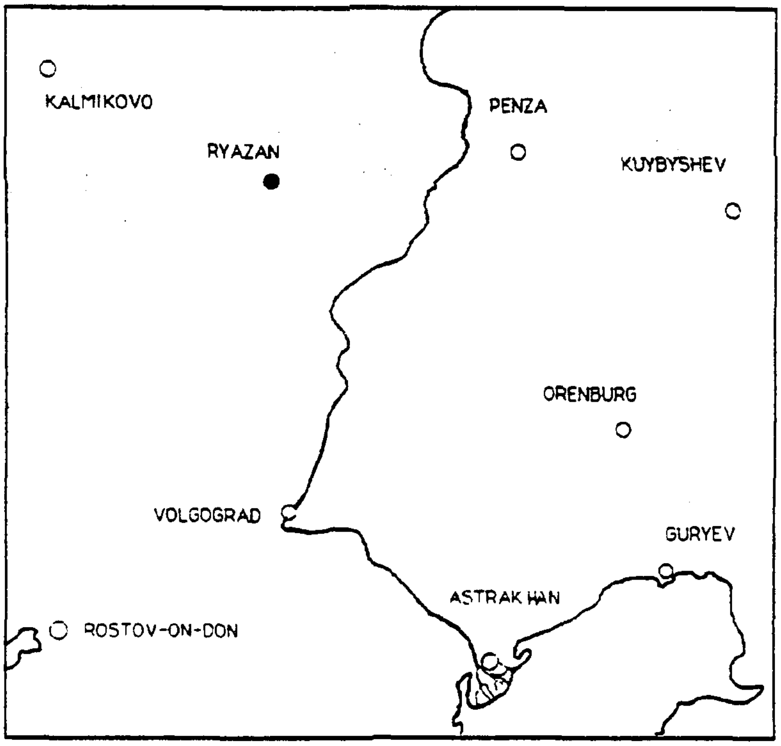
APPENDIX F

CLIMATOLOGICAL DATA FOR RYAZAN, RS

STATION: RYAZAN, RS

LOCATION: 54° 37' N 39° 44' E

ELEVATION: 135 m



RYAZAN, RS
CLIMATOLOGICAL DATA.
PERIOD OF RECORD: 1959-1986

	MONTH / TIME	value	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
T (K)	morning	max	289.2	299.2	290.0	304.0	294.8	302.2	300.8	301.2	295.2	304.0	306.2	294.5
		mean	267.9	267.7	272.0	280.0	286.1	289.8	291.9	290.9	285.7	279.5	275.1	277.7
		min	246.0	246.9	252.0	237.2	253.2	265.2	256.2	253.6	272.0	261.5	256.9	260.8
	afternoon	max	287.2	305.2	305.0	304.0	313.2	310.2	317.2	310.2	305.2	300.2	294.5	293.2
		mean	269.9	270.4	276.2	286.8	293.4	297.2	299.6	298.7	293.3	285.1	277.7	271.1
		min	249.0	249.1	246.0	271.9	274.0	277.2	273.0	284.1	269.0	268.0	260.8	249.1
T_d (K)	morning	max	280.5	280.2	283.0	287.0	291.6	294.1	296.4	295.2	292.0	289.1	285.2	283.0
		mean	266.0	265.7	270.2	276.7	281.6	285.3	286.8	285.5	281.4	276.7	273.2	269.6
		min	235.2	240.2	235.0	242.2	235.0	251.2	253.3	253.2	236.0	231.0	230.0	237.0
	afternoon	max	287.2	300.2	285.2	295.0	291.2	298.0	295.0	295.8	293.0	290.0	285.8	283.2
		mean	267.1	266.8	271.1	277.0	282.3	285.4	286.9	285.9	282.1	277.9	274.0	270.3
		min	235.2	227.0	237.0	235.0	253.2	253.2	246.0	253.2	235.0	253.0	238.2	235.2
RH (%)	morning	mean	86	85	88	78	81	87	88	88	88	88	89	88
	afternoon	mean	83	76	72	57	47	51	55	55	61	71	83	85
SLP (mb)	morning	max	1064.3	1057.0	1047.6	1050.9	1031.1	1046.2	1058.0	1040.5	1036.0	1037.5	1042.4	1058.1
		mean	1020.9	1020.5	1020.1	1014.9	1015.0	1012.5	1011.4	1012.8	1017.0	1020.5	1021.0	1019.8
		min	991.2	971.0	986.3	976.0	984.7	998.9	987.9	972.9	976.2	988.8	950.5	990.8
	afternoon	max	1049.2	1059.5	1050.7	1032.2	1032.6	1033.7	1022.6	1033.7	1073.0	1037.9	1051.4	1063.0
		mean	1020.7	1020.5	1020.2	1014.9	1014.9	1012.3	1011.1	1012.7	1016.8	1020.2	1020.9	1019.6
		min	987.3	993.0	966.3	970.7	982.2	981.2	999.2	966.3	997.0	997.6	986.2	988.5
R (mm)	monthly	max	111.8	83.8	78.7	73.7	116.8	116.8	167.6	195.6	121.9	137.2	127.0	116.8
		mean	38.1	33.0	33.0	30.5	43.2	50.8	61.0	58.4	43.2	40.6	38.1	38.1
		min	10.2	T	7.6	2.5	5.1	7.6	2.5	2.5	T	2.5	7.6	2.5
	24-hour	max	22.9	20.3	25.4	22.9	50.8	66.0	76.2	91.4	43.2	38.1	48.3	27.9

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	E,W/E,W	E,NE/E, W	E,NE/E, W	E,NE/E, W	E,NE/E, W	E,NE/E, W	NE,NW/ E,W	E,NE/E, W	E,NE/E, W	E,W/E,W	E,W/E,W	E,W/E,W
WND SP (kt)	am/pm	14/15	17/18	15/17	13/16	12/15	10/12	9/13	10/13	11/14	12/14	13/14	13/14
VIS (%)	am/pm												
[nm] < 0.5		11/7	12/6	9/3	4/1	2/*	2/*	1/*	1/*	1/*	4/1	9/6	16/12
0.5-1.5		9/13	11/10	7/6	5/2	3/*	2/*	1/*	2/*	2/*	5/3	9/9	14/15
1.5-3		14/18	13/15	15/11	10/5	7/1	7/1	7/1	6/1	7/2	11/8	15/15	14/18
>3		66/62	64/68	69/80	82/92	88/99	89/98	91/99	91/98	89/98	81/88	67/70	56/55
SKY (%)	am/pm												
PCLDY		27/21	29/25	34/30	46/33	54/38	65/47	75/56	73/58	71/54	54/42	28/24	18/15
MCLDY		15/28	16/31	17/35	26/45	30/51	26/47	20/39	19/36	20/38	22/40	19/32	16/24
OVC		44/40	40/35	38/32	24/22	14/11	8/6	4/5	7/6	9/8	19/18	40/36	46/43
OBSC		15/10	15/8	11/3	4/1	2/0	1/0	*/0	1/0	1/*	5/*	13/7	21/18
CIG (%)	am/pm												
HIGH		30/32	33/38	39/44	56/53	67/62	74/62	82/67	79/69	76/68	58/55	31/34	20/22
MIDDLE		10/12	10/16	10/14	22/20	19/18	19/19	14/18	16/17	14/17	13/14	12/12	9/12
LOW		60/56	57/46	51/43	21/27	14/20	7/19	4/15	5/14	10/15	29/31	57/54	71/66
WX (%)	am/pm												
DUST		5/7	10/13	4/4	*/1	*/*	0/0	*/*	0/*	*/0	*/*	*/1	5/5
HZ&SM		*/1	*/*	*/1	1/1	*/*	*/*	*/*	*/*	*/*	*/1	*/1	*/*
FOG		12/6	12/4	10/3	3/*	2/0	1/0	1/0	1/*	1/*	5/*	11/5	15/13
DRIZZLE		3/2	3/2	3/1	1/1	*/0	*/*	0/0	*/0	0/0	1/1	5/4	6/4
RAIN		7/7	4/6	6/5	8/4	3/1	1/*	*/*	*/1	2/2	4/3	8/8	12/11
SHOWERS		2/3	3/3	2/2	4/5	5/5	3/4	2/4	3/3	3/3	2/3	4/4	3/4
TSTMS		0/0	0/0	0/0	0/*	1/1	1/2	1/1	1/1	*/*	0/*	0/0	0/0
SNOW		15/17	13/13	8/6	1/1	0/0	0/0	0/0	*/*	0/0	1/*	3/4	11/13
NONE		56/56	54/59	68/79	83/87	89/93	93/94	95/94	95/95	93/94	86/90	69/74	48/50

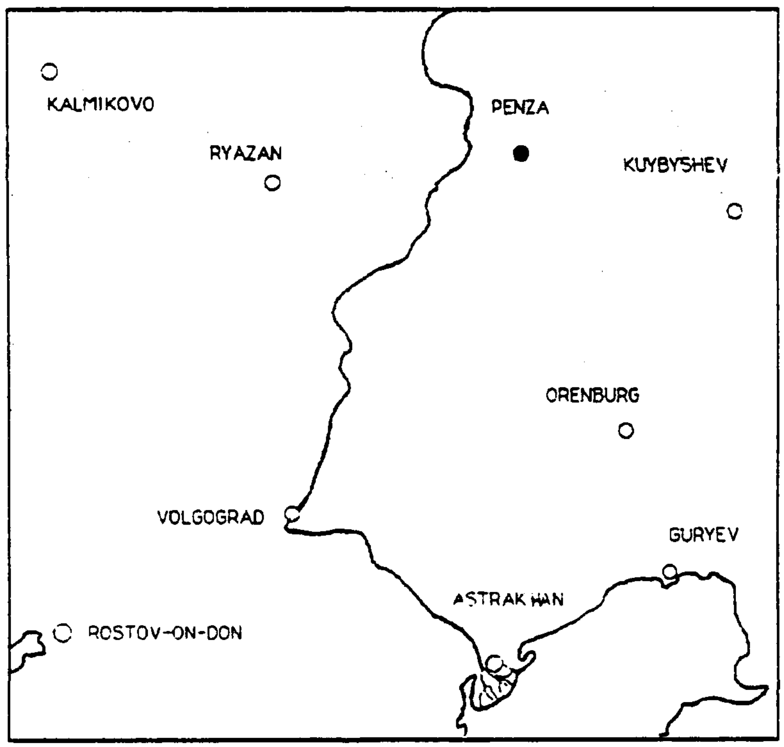
APPENDIX G

CLIMATOLOGICAL DATA FOR PENZA, RS

STATION: PENZA, RS

LOCATION: 53° 08' N 45° 02' E

ELEVATION: 235 m



PENZA, RS
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	276.9	276.6	288.0	290.2	293.2	296.0	298.2	297.2	296.2	300.0	281.9	297.0
		mean	261.4	260.3	266.2	275.7	282.2	285.7	287.7	286.0	281.2	275.5	270.3	264.9
		min	235.2	234.0	241.9	255.8	270.2	262.4	268.2	274.0	268.0	256.9	244.1	235.2
	afternoon	max	281.0	278.2	288.5	300.8	305.2	308.0	309.2	309.1	305.4	296.0	306.0	280.2
		mean	263.3	263.9	270.7	282.4	291.3	294.3	296.2	294.8	288.6	279.6	271.8	266.0
		min	242.0	241.0	249.1	256.9	273.3	277.2	266.2	280.2	274.1	263.0	248.0	238.0
T_d (K)	morning	max	276.9	274.5	276.2	285.2	288.1	291.2	291.9	292.2	288.2	286.0	280.8	277.2
		mean	259.1	257.9	264.2	272.8	277.7	282.5	285.3	283.4	278.7	273.3	268.6	262.7
		min	230.2	230.0	229.0	246.9	239.0	261.4	243.0	253.0	244.2	253.0	231.2	232.2
	afternoon	max	281.0	276.2	283.0	286.9	291.2	292.8	297.2	295.2	291.2	287.0	281.9	279.2
		mean	260.5	260.4	266.5	273.3	277.1	282.3	285.3	283.5	279.1	273.9	269.1	263.3
		min	245.0	246.0	244.1	250.2	241.0	265.2	253.2	261.0	262.0	243.0	238.0	232.2
RH (%)	morning	mean	83	83	87	82	75	81	86	87	87	87	88	84
	afternoon	mean	80	75	72	54	43	49	53	50	53	68	83	82
SLP (mb)	morning	max	1071.7	1057.7	1058.3	1039.6	1035.4	1032.4	1028.5	1027.3	1037.6	1043.5	1065.6	1055.2
		mean	1021.6	1023.7	1023.0	1017.3	1017.1	1012.5	1011.1	1014.3	1016.7	1018.6	1020.3	1020.5
		min	952.0	981.4	974.0	979.0	992.0	987.0	979.1	975.9	987.2	981.4	982.8	985.5
	afternoon	max	1061.8	1055.3	1058.3	1043.1	1033.2	1030.7	1042.7	1053.5	1036.3	1053.5	1048.0	1057.0
		mean	1021.1	1023.0	1022.8	1017.1	1016.2	1011.7	1010.5	1013.7	1016.2	1018.3	1020.2	1020.3
		min	978.0	971.1	974.7	987.5	985.5	984.8	971.2	990.6	995.4	981.2	965.5	978.4
R (mm)	monthly	max	***	***	***	***	***	***	***	***	***	***	***	***
		mean	33.0	22.9	22.9	30.5	45.7	55.9	55.9	50.8	48.3	43.2	40.6	1.4
		min	***	***	***	***	***	***	***	***	***	***	***	***
	24-hour	max	22.9	15.2	25.4	30.5	43.2	33.0	76.2	48.3	61.0	35.6	25.4	22.9

am/pm	S,SW/S, SW	S,SW/S,S W	S,SW/S, SW	S,SW/S, SE,W	S,SW/S, W	SW,S/W, NW	SW,S/W, NW	SW,S/W, NW	SW,S/W, S	SW,S/S, W	S-SW,W/ S,SW	S,SW/S, SW
am/pm	13/13	13/13	12/13	11/14	9/14	7/11	7/11	7/11	8/12	10/14	12/13	15/13
am/pm												
	5/5	6/4	6/2	3/1	1/*	1/*	2/1	3/*	4/*	5/1	5/5	4/4
	9/10	9/9	7/6	3/1	1/*	1/0	1/*	2/*	2/*	3/4	6/8	7/10
	38/43	32/39	29/32	18/12	8/3	8/3	13/2	13/5	13/8	15/22	26/35	31/40
	48/42	53/48	58/59	76/86	90/97	90/97	84/97	82/95	81/92	76/73	63/52	58/46
am/pm												
	19/15	27/25	29/28	43/31	51/31	51/28	54/29	57/34	48/29	30/21	18/15	19/16
	16/26	14/27	14/28	24/41	27/47	33/55	29/56	23/50	23/46	21/35	16/25	15/24
	57/49	51/41	48/40	30/27	21/22	17/17	15/14	18/16	27/25	44/42	59/52	59/53
	8/9	9/7	9/4	3/1	1/0	*/0	1/0	2/0	2/0	5/2	8/8	7/7
am/pm												
	24/27	32/40	35/46	55/53	63/51	63/46	64/45	64/47	53/46	34/34	21/23	23/25
	13/21	13/21	16/23	23/22	25/27	27/24	25/28	25/28	25/26	19/21	10/14	10/17
	63/52	55/39	48/31	22/25	12/22	10/30	11/27	12/26	22/29	47/45	69/63	68/58
am/pm												
	10/13	9/13	3/5	*/*	0/0	0/0	0/0	0/0	0/0	*/*	1/2	4/6
	0/*	*/0	0/*	*/*	0/*	*/*	*/*	0/*	*/1	0/*	0/*	*/0
	3/1	6/1	8/1	3/*	1/0	1/0	3/0	4/0	6/0	6/1	5/4	2/2
	4/2	3/2	2/2	1/1	1/*	*/0	*/*	*/0	1/*	2/2	7/6	6/5
	2/2	2/1	5/4	7/5	5/2	3/2	2/1	4/3	6/6	10/2	8/8	5/4
	1/3	1/1	1/2	2/3	4/5	3/5	4/5	3/4	3/4	2/5	3/6	2/2
	0/0	0/0	0/0	0/*	*/2	1/3	1/3	1/1	*/*	0/0	0/*	0/0
	42/43	35/29	22/17	4/2	*/*	0/0	0/0	0/0	*/*	7/5	19/22	35/36
	38/36	43/52	60/69	82/88	89/92	92/90	90/91	89/92	84/89	74/77	56/53	46/44

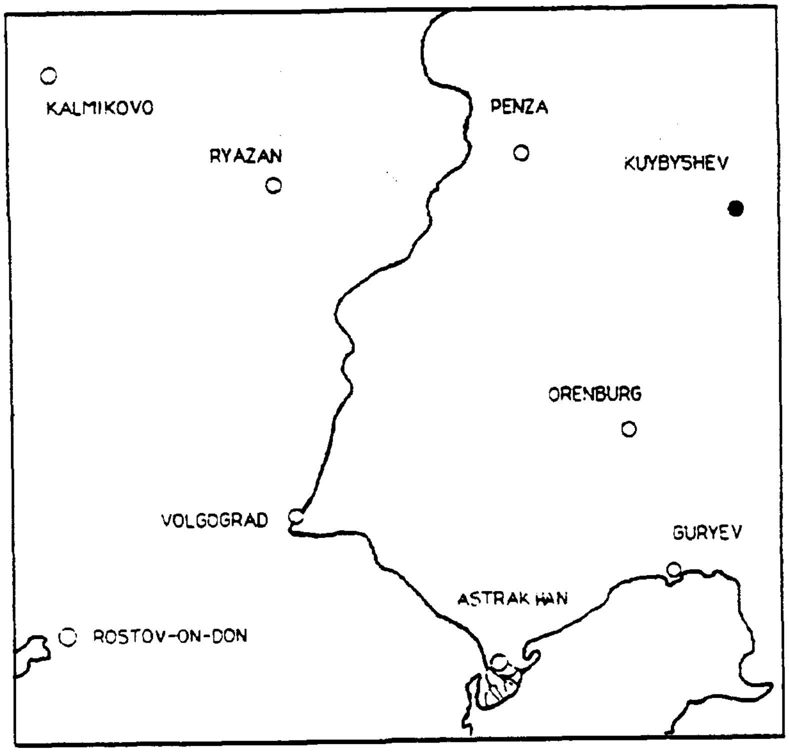
APPENDIX H

CLIMATOLOGICAL DATA FOR KUYBYSHEV/KURUMOCH. RA

STATION: KUYBYSHEV KURUMOCH, RA

LOCATION: 53° 15' N 50° 28' E

ELEVATION: 44 m



KUYBYSHEV/KURUMOCH, RA
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T	morning	max	301.0	303.0	290.2	290.8	303.2	299.0	303.2	303.2	295.2	300.2	283.0	300.0
(K)		mean	260.3	259.0	265.6	275.7	283.1	287.0	289.3	286.7	281.1	275.0	269.7	264.1
		min	232.2	235.0	238.0	250.8	270.8	263.0	253.0	268.7	265.8	258.0	245.2	233.2
	afternoon	max	301.2	274.4	295.2	314.2	305.2	310.0	312.0	309.1	307.2	303.2	284.1	299.0
		mean	262.6	259.7	270.9	283.6	293.0	295.8	298.0	296.2	289.9	280.1	271.8	265.5
		min	247.2	249.2	251.4	260.8	241.0	278.0	284.1	280.2	274.7	265.2	246.2	233.2
Td	morning	max	274.7	275.2	279.2	285.8	289.2	292.5	293.4	302.2	289.1	284.5	280.8	277.2
(K)		mean	258.1	256.8	263.7	272.9	277.8	283.2	286.1	283.7	278.6	272.7	267.9	261.9
		min	228.2	231.0	234.1	236.2	237.0	260.9	253.0	251.2	243.0	242.2	243.0	239.2
	afternoon	max	274.4	274.2	280.2	286.4	290.8	295.8	301.5	294.0	290.2	288.0	282.2	277.2
		mean	259.7	259.9	266.8	273.5	277.0	282.8	285.7	283.6	279.1	273.6	268.9	262.8
		min	239.2	238.2	245.8	250.8	255.2	253.2	271.0	269.1	252.2	237.2	245.2	223.2
RH	morning	mean	88	85	90	92	72	81	92	87	86	95	92	85
(%)	afternoon	mean	79	69	72	51	32	36	46	38	51	67	78	80
SLP	morning	max	1061.9	1054.0	1057.3	1045.4	1040.9	1055.2	1024.8	1046.0	1042.2	1047.0	1053.1	1059.1
(mb)		mean	1021.8	1024.1	1023.8	1018.0	1017.3	1011.7	1010.1	1013.6	1016.2	1019.0	1021.6	1022.1
		min	974.5	979.8	986.0	981.9	992.3	955.2	975.8	976.3	947.4	985.4	982.5	980.9
	afternoon	max	1062.4	1054.5	1058.0	1045.2	1048.4	1028.9	1028.2	1028.1	1036.5	1046.5	1051.8	1058.8
		mean	1022.0	1024.0	1023.9	1017.7	1016.8	1011.3	1009.9	1013.2	1015.8	1018.9	1021.6	1022.0
		min	973.2	979.8	978.3	976.0	990.8	993.3	973.2	989.2	990.4	983.4	978.3	984.2
R	monthly	max	73.7	58.4	58.4	58.4	66.0	61.0	114.3	61.0	66.0	68.6	81.3	109.2
(mm)		mean	12.7	15.2	10.2	22.9	27.9	27.9	33.0	15.2	30.5	27.9	22.9	22.9
		min	0.0	T	T	2.5	2.5	5.1	7.6	5.1	7.6	2.5	5.1	5.1
	24-hour	max	17.8	15.2	27.9	35.6	22.9	35.6	33.0	30.5	33.0	17.8	30.5	22.9

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	S,SW/S SW,E	S-SW,E /S,SW	SW,S,E/ S,SW	NE-E, NW/S,E	NE,NW/ W,NW,S	NW,N/ NW,W	NW,NE/ NW,W	NW,N/ NW,W	NW,W/ W,NW	SW,NW/ SW,W	SW,S/ SW,S	S,SW/S, SW
WND SP (kt)	am/pm	11/12	11/11	11/11	8/13	9/13	9/12	8/12	9/11	10/12	11/13	12/11	12/12
VIS (%)	am/pm												
[nm] < 0.5		3/4	3/3	6/2	3/1	1/*	2/*	1/0	1/*	3/*	3/1	3/2	3/4
0.5-1.5		11/19	13/17	11/11	5/2	1/*	1/0	2/*	2/*	3/1	5/5	8/12	10/15
1.5-3		49/43	47/40	43/33	28/10	8/3	14/2	14/2	14/3	19/7	25/21	33/33	43/41
>3		37/34	37/40	40/53	65/87	90/97	83/98	83/97	82/97	75/92	67/73	56/53	44/40
SKY (%)	am/pm												
PCLDY		26/20	29/30	30/32	51/38	57/40	55/40	55/42	58/46	50/35	30/24	24/21	24/21
MCLDY		12/24	14/26	19/32	24/40	31/46	32/50	33/51	30/44	31/47	29/43	20/32	14/26
OVC		59/50	52/41	43/34	22/22	12/13	12/10	12/7	12/9	18/18	38/32	52/44	58/48
OBSC		4/6	5/3	9/2	3/*	1/1	1/0	*/0	*/*	2/0	3/1	3/2	4/5
CIG (%)	am/pm												
HIGH		29/33	36/48	37/50	62/59	69/65	65/59	65/59	66/61	58/52	36/38	29/34	32/33
MIDDLE		15/18	18/23	20/21	16/17	20/17	19/20	22/23	21/22	21/24	19/19	12/14	12/16
LOW		56/48	46/29	43/28	22/24	11/18	15/21	13/18	12/16	21/25	45/44	60/52	57/51
WX (%)	am/pm												
DUST		7/10	7/11	3/4	*/*	0/*	0/0	0/0	0/0	0/*	*/*	2/1	3/5
HZ&SM		*/1	1/2	*/1	1/1	*/1	1/1	*/1	0/1	*/1	*/1	0/*	*/1
FOG		1/1	3/2	7/1	3/*	1/0	2/0	*/0	1/0	3/0	3/1	3/2	3/2
DRIZZLE		2/1	2/1	2/1	*/*	*/0	0/*	*/*	0/*	0/*	2/1	4/3	4/2
RAIN		1/1	2/1	3/2	6/4	2/1	2/1	1/*	2/1	4/3	9/8	5/8	3/2
SHOWERS		0/1	1/1	1/2	4/4	3/4	4/4	5/3	4/3	3/5	5/8	3/5	2/2
TSTMS		0/0	*/0	0/0	0/0	*/1	*/2	1/2	1/1	*/*	*/0	0/0	0/0
SNOW		44/42	38/29	24/16	2/1	0/0	0/0	0/0	0/0	0/0	5/3	15/15	34/33
NONE		44/44	47/54	60/73	84/90	94/94	91/92	92/94	92/93	89/90	76/77	69/66	51/53

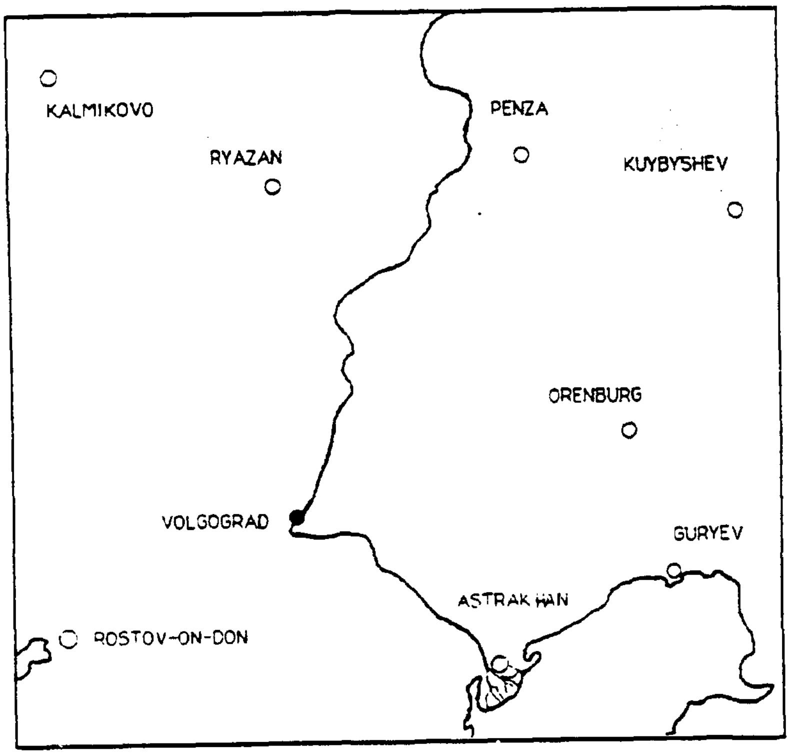
APPENDIX I

CLIMATOLOGICAL DATA FOR VOLGOGRAD, RS

STATION: VOLGOGRAD, RS

LOCATION: 48° 41' N 44° 22' E

ELEVATION: 42 m



VOLGOGRAD, RS
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	279.1	279.1	283.0	299.6	298.0	298.0	304.1	300.2	298.0	289.1	284.1	279.1
		mean	264.0	263.3	268.7	278.2	284.9	289.1	291.9	290.4	284.4	277.6	272.1	267.0
		min	241.9	243.0	248.0	265.2	272.0	266.3	281.9	276.9	271.0	260.8	253.0	245.2
	afternoon	max	276.9	284.1	288.0	301.9	304.1	310.2	310.8	310.2	305.2	298.0	289.1	283.0
		mean	265.9	265.9	272.6	285.8	293.3	297.6	300.7	299.1	292.5	283.5	274.5	268.5
		min	245.8	246.9	254.1	266.9	275.5	279.1	289.1	284.1	277.6	265.8	256.9	245.8
T_d (K)	morning	max	276.9	276.9	280.8	285.2	288.0	291.9	293.0	291.9	286.9	285.2	283.0	279.1
		mean	262.4	261.3	267.0	273.6	278.3	282.7	284.4	283.3	279.0	274.7	270.5	265.6
		min	238.0	238.0	245.2	263.0	263.0	238.0	264.8	270.2	266.9	259.1	250.8	228.0
	afternoon	max	275.8	280.8	281.9	285.8	290.2	291.9	293.0	295.2	290.2	286.9	284.1	281.9
		mean	263.6	263.1	268.8	273.4	277.9	281.9	283.5	282.7	278.7	275.6	271.0	266.5
		min	239.1	238.0	250.2	256.9	260.8	266.9	265.8	271.8	264.1	261.9	254.1	243.0
RH	morning	mean	87	86	89	80	69	70	71	71	77	85	90	90
(%)	afternoon	mean	84	79	75	49	41	39	39	38	44	59	80	87
SLP (mb)	morning	max	1054.8	1052.3	1046.0	1034.7	1032.7	1024.6	1023.5	1025.3	1032.0	1041.1	1042.7	1047.4
		mean	1023.1	1022.7	1022.2	1018.6	1016.4	1012.5	1012.1	1013.5	1017.8	1021.1	1022.2	1021.7
		min	990.2	988.5	992.8	997.5	999.8	998.8	1000.1	994.2	1004.8	998.1	991.8	993.4
	afternoon	max	1054.1	1051.0	1045.7	1035.4	1033.4	1024.0	1021.8	1024.6	1033.5	1052.5	1043.6	1047.8
		mean	1023.1	1022.4	1021.9	1018.1	1016.0	1011.9	1011.4	1013.0	1017.3	1020.7	1022.3	1021.6
		min	994.0	991.1	993.9	998.0	997.9	999.7	1000.2	999.7	1002.2	997.3	987.1	995.0
R (mm)	monthly	max	55.9	38.1	40.6	20.3	68.6	81.3	38.1	61.0	48.3	25.4	78.7	88.9
		mean	33.0	25.4	27.9	17.8	40.6	33.0	22.9	30.5	15.2	15.2	43.2	43.2
		min	***	***	***	***	***	***	***	***	***	***	***	***
	24-hour	max	20.3	25.4	20.3	17.8	33.0	81.3	30.5	50.8	30.5	20.3	27.9	35.6

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	S-W,SW/ S,W	S,W/S,W	S-W,SW/ S-W,SW	S,W/S,E, W	S-W,SW /E-W,S	W,NW/ NW,W	W,NW/ NW,W	W,NW/ NW,W	W,SW/W NW	W,SW,S/ W,S	S,W/S,W	S,W/S,W
WND SP (kt)	am/pm	9/11	11/11	9/10	8/12	6/10	6/10	6/10	6/9	7/10	8/10	10/10	11/11
VIS (%)	am/pm												
(nm) < 0.5		8/4	7/4	11/4	6/2	2/*	2/*	2/*	3/*	4/*	6/3	13/6	10/7
0.5-1.5		18/21	1[illegible]/16	12/14	5/4	2/1	2/*	3/*	4/1	5/2	8/8	10/15	16/22
1.5-3		19/30	18/24	17/21	11/11	6/4	7/2	13/3	11/4	12/7	10/12	15/23	20/25
>3		55/45	60/56	60/61	78/82	90/95	89/97	82/97	82/95	79/90	76/77	61/55	54/46
SKY (%)	am/pm												
PCLDY		25/20	35/29	34/32	39/28	47/30	48/27	48/29	51/31	43/27	32/19	20/16	19/15
MCLDY		14/17	11/16	14/21	20/33	25/43	28/49	27/48	24/45	25/42	19/34	13/20	11/14
OVC		51/58	46/50	39/41	35/37	26/27	22/24	23/23	23/24	28/31	42/44	50/54	58/62
OBSC		10/5	8/5	14/5	6/2	1/*	1/0	2/0	2/0	5/*	7/3	17/11	13/9
CIG (%)	am/pm												
HIGH		29/30	40/43	42/50	51/48	59/48	61/41	61/41	60/44	51/41	37/30	23/24	21/22
MIDDLE		9/12	12/15	10/15	15/14	18/13	17/13	17/12	18/15	17/14	11/14	8/8	7/10
LOW		62/57	48/42	48/36	34/38	23/40	22/46	22/47	21/41	32/45	52/56	69/68	72/68
WX (%)	am/pm												
DUST		10/10	9/9	5/6	*/*	0/0	0/0	0/*	0/0	0/0	*/*	2/2	8/7
HZ&SM		*/1	*/1	*/2	*/1	*/0	*/*	*/*	*/*	*/*	*/*	*/0	*/1
FOG		6/2	7/2	11/3	5/1	1/*	1/*	2/0	3/0	4/*	6/2	11/6	9/5
DRIZZLE		1/1	2/1	1/1	1/1	*/*	*/*	1/*	1/*	1/1	2/2	5/5	4/4
RAIN		2/3	2/3	4/5	8/7	5/6	4/3	4/3	5/5	8/7	11/10	9/11	4/5
SHOWERS		1/2	1/3	1/2	2/4	2/3	4/5	2/3	3/3	3/4	2/4	1/4	1/2
TSTMS		0/0	0/0	*/0	*/*	*/1	*/2	1/1	1/1	0/*	0/*	0/0	0/0
SNOW		31/43	25/32	14/14	3/2	*/0	0/0	0/0	0/0	*/0	3/4	14/21	29/41
NONE		48/38	55/50	63/67	81/84	90/89	90/90	89/92	88/90	83/88	75/78	58/52	45/36

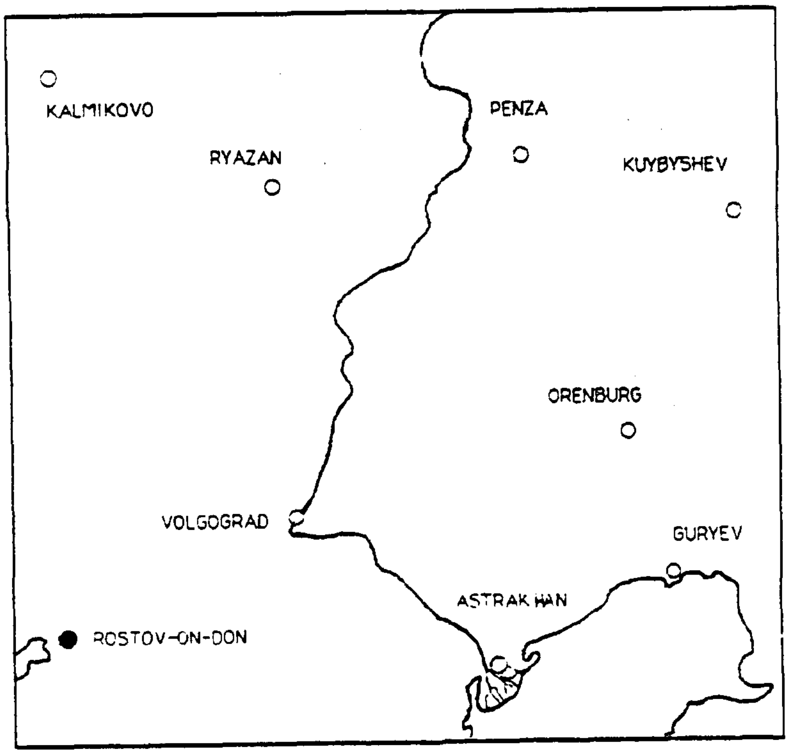
APPENDIX J

CLIMATOLOGICAL DATA FOR ROSTOV-ON-DON, RS

STATION: ROSTOV-ON-DON, RS

LOCATION: 47° 15' N 39° 50' E

ELEVATION: 77 m



ROSTOV-ON-DON, RS
CLIMATOLOGICAL DATA
PERIOD OF RECORD: 1959-1986

	MONTH		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME	value												
T (K)	morning	max	290.0	290.2	298.2	295.0	293.2	304.0	298.0	295.0	294.1	303.0	283.0	295.2
		mean	262.5	262.1	267.5	276.1	282.7	286.1	288.0	286.5	281.7	276.2	270.8	266.0
		min	239.2	241.9	246.9	251.9	260.2	264.7	275.2	275.2	270.0	259.1	248.0	235.2
	afternoon	max	289.2	275.2	287.4	298.0	304.2	306.2	308.2	306.9	304.1	303.0	285.2	279.2
		mean	263.7	264.5	271.0	281.3	289.9	293.1	295.0	293.4	287.5	279.5	272.0	266.6
		min	245.2	244.1	253.0	263.0	273.0	273.2	274.2	273.2	273.0	264.1	251.8	236.2
Td (K)	morning	max	275.2	276.0	278.0	284.1	288.9	293.2	293.2	291.2	289.2	285.6	283.0	292.2
		mean	260.4	259.8	265.4	273.2	278.5	282.5	285.3	284.0	279.5	274.2	269.2	264.2
		min	232.0	235.0	243.5	243.0	240.0	226.0	244.0	249.0	249.0	256.9	231.0	231.0
	afternoon	max	275.2	275.2	281.0	287.2	291.0	293.2	294.4	294.2	293.3	292.6	283.0	278.1
		mean	261.3	261.3	266.9	273.5	277.9	282.2	285.0	284.0	279.8	274.7	269.6	264.5
		min	236.0	240.2	231.2	253.0	237.0	244.2	250.0	235.0	238.2	235.0	248.5	232.2
RH (%)	morning	mean	87	87	88	83	78	77	78	75	80	85	88	89
	afternoon	mean	79	72	65	54	49	47	49	45	49	61	77	83
SLP (mb)	morning	max	1057.2	1055.2	1057.7	1037.6	1035.0	1033.7	1030.6	1028.6	1062.0	1042.5	1048.6	1048.9
		mean	1018.9	1021.5	1020.5	1015.7	1016.4	1012.6	1011.2	1014.1	1015.8	1017.4	1018.0	1017.3
		min	950.5	973.7	950.9	980.9	981.1	984.4	965.7	988.8	975.3	975.5	969.4	[illegible]
	afternoon	max	1057.0	1055.1	1057.0	1037.3	1034.2	1033.6	1031.6	1028.8	1041.2	1060.0	1048.1	[illegible]
		mean	1019.1	1021.5	1020.7	1015.5	1016.2	1012.2	1010.9	1013.9	1015.5	1017.5	1017.9	[illegible]
		min	971.1	973.6	973.4	978.7	992.7	973.7	964.5	968.6	978.5	979.9	974.3	972.5
R (mm)	monthly	max	86.4	124.5	81.2	86.4	96.5	154.9	119.4	111.8	94.0	86.4	137.2	[illegible]
		mean	35.6	35.6	33.0	33.0	48.3	61.0	55.9	30.5	30.5	33.0	38.1	38.1
		min	5.1	2.5	T	T	T	5.1	T	T	0.0	0.0	5.1	5.1
	24-hour	max	25.4	25.4	25.4	30.5	48.3	63.5	48.3	71.1	35.6	27.9	35.6	27.9

variable	MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
	TIME												
PVLG DD	am/pm	S-W,SW/S,W	S,W/S,W	S-W,SW/S-W,SW	S,W/S,E,W	S-W,SW/E-W,S	W,NW/NW,W	W,NW/NW,W	W,NW/NW,W	W,SW/W NW	W,SW,S/W,S	S,W/S,W	S,W/S,W
WND SP (kt)	am/pm	9/11	11/11	9/10	8/12	6/10	6/10	6/10	6/9	7/10	8/10	10/10	11/11
VIS (%)	am/pm												
[nm] < 0.5		8/4	7/4	11/4	6/2	2/*	2/*	2/*	3/*	4/*	6/3	13/6	10/7
0.5-1.5		18/21	15/16	12/14	5/4	2/1	2/*	3/*	4/1	5/2	8/8	10/15	16/22
1.5-3		19/30	18/24	17/21	11/11	6/4	7/2	13/3	11/4	12/7	10/12	15/23	20/25
>3		55/45	60/56	60/61	78/82	90/95	89/97	82/97	82/95	79/90	76/77	61/55	54/46
SKY (%)	am/pm												
PCLDY		25/20	35/29	34/32	39/28	47/30	48/27	48/29	51/31	43/27	32/19	20/16	19/15
MCLDY		14/17	11/16	14/21	20/33	25/43	28/49	27/48	24/45	25/42	19/34	13/20	11/14
OVC		51/58	46/50	39/41	35/37	26/27	22/24	23/23	23/24	28/31	42/44	50/54	58/62
OBSC		10/5	8/5	14/5	6/2	1/*	1/0	2/0	2/0	5/*	7/3	17/11	13/9
CIG (%)	am/pm												
HIGH		29/30	40/43	42/50	51/48	59/48	61/41	61/41	60/44	51/41	37/30	23/24	21/22
MIDDLE		9/12	12/15	10/15	15/14	18/13	17/13	17/12	18/15	17/14	11/14	8/8	7/10
LOW		62/57	48/42	48/36	34/38	23/40	22/46	22/47	21/41	32/45	52/56	69/68	72/68
WX (%)	am/pm												
DUST		10/10	9/9	5/6	*/*	0/0	0/0	0/*	0/0	0/0	*/*	2/2	8/7
HZ&SM		*/1	*/1	*/2	*/1	*/0	*/*	*/*	*/*	*/*	*/*	*/0	*/1
FOG		6/2	7/2	11/3	5/1	1/*	1/*	2/0	3/0	4/*	6/2	11/6	9/5
DRIZZLE		1/1	2/1	1/1	1/1	*/*	*/*	1/*	1/*	1/1	2/2	5/5	4/4
RAIN		2/3	2/3	4/5	8/7	5/6	4/3	4/3	5/5	8/7	11/10	9/11	4/5
SHOWERS		1/2	1/3	1/2	2/4	2/3	4/5	2/3	3/3	3/4	2/4	1/4	1/2
TSTMS		0/0	0/0	*/0	*/*	*/1	*/2	1/1	1/1	0/*	0/*	0/0	0/0
SNOW		31/43	25/32	14/14	3/2	*/0	0/0	0/0	0/0	*/0	3/4	14/21	29/41
NONE		48/38	55/50	63/67	81/84	90/89	90/90	89/92	88/90	83/88	75/78	58/52	45/36

VITA

Jeffrey Edward Johnson's permanent address is 546 Ulukanu Street, Kailua, Hawaii 96734. Jeff graduated from Kailua High School in 1976—graduating in the top 2% of his class. He attended his first year of college at the University of Hawaii, whereupon he transferred to the University of Colorado where he completed a double degree in Chemical Engineering and Psychology (Bachelor of Science and Bachelor of Arts, respectively) in 1982.

After graduation, Jeff worked as a substitute teacher for several high schools in Hawaii. He taught mathematics, science, and history. He also put his psychology degree to use and worked as a psychiatric counselor before joining the Air Force.

After being commissioned a Second Lieutenant in the United States Air Force in 1984, Lieutenant Johnson attended the Basic Meteorology Program at San Jose State University. His next assignment was to Tinker Air Force Base in Oklahoma City, Oklahoma where he held positions as a duty forecaster and a Wing Weather Officer for the 552nd Airborne Warning and Control Squadron (AWACS). Following the Tinker assignment, 1Lt Johnson was assigned to Osan AB, Korea where he was a section chief in the Korean Forecast Unit—a centralized facility disseminating weather information to the entire Korean peninsula and adjacent waters. After 13 months in Korea, 1Lt Johnson attended Texas A&M University. In May 1988, he was promoted to the rank of Captain and offered a regular commission in the USAF.

Jeff teaches classes in CPR and first aid for the Red Cross. Other avocations include reading, martial arts, and cooking.